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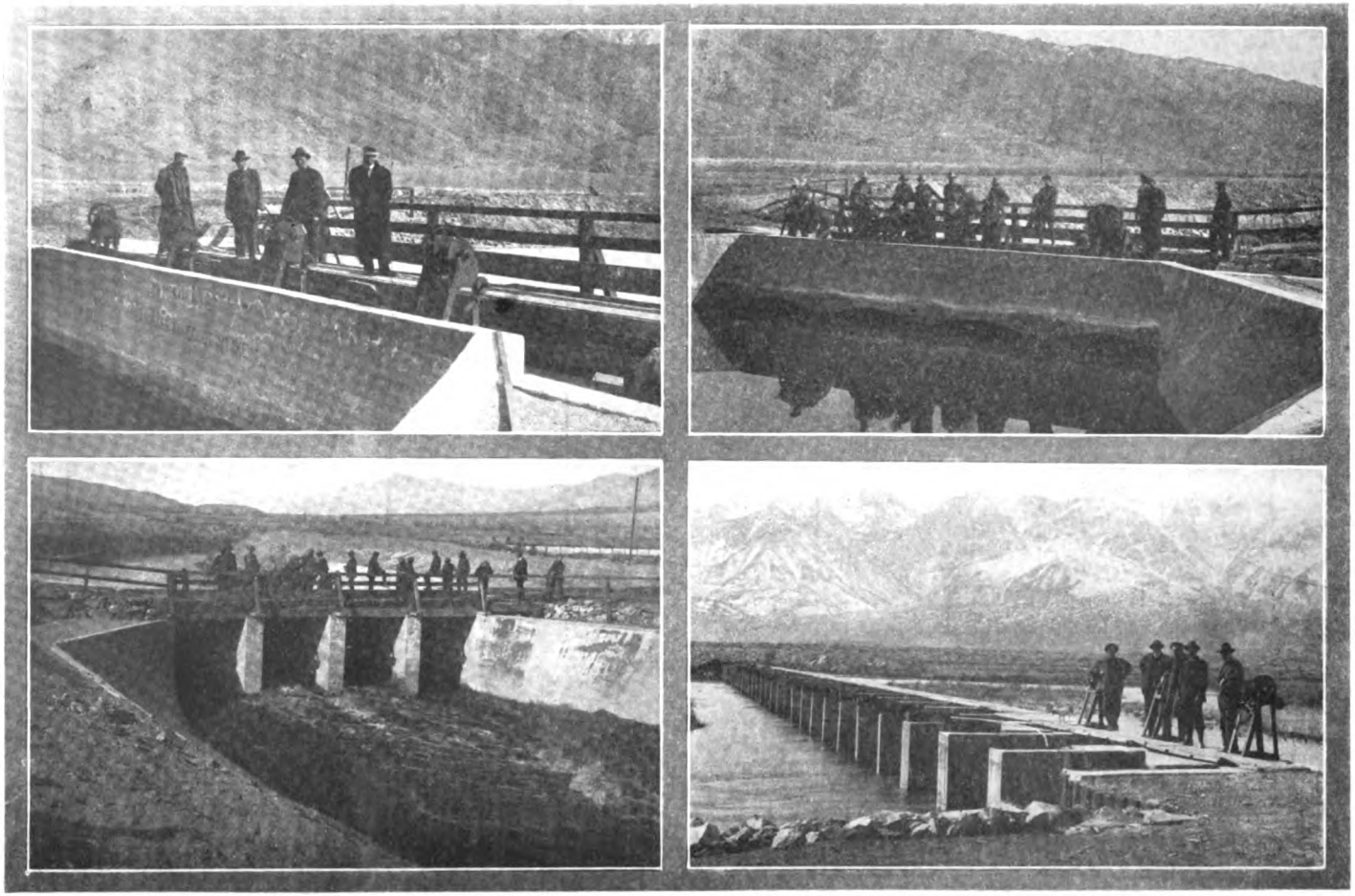

SCENES ATTENDING THE OPENING OF THE LOS ANGELES AQUEDUCT.

Inspection of Intake before opening, February 12, 1913.
Intake Gates, Canal Side, after opening.
Opening of Intake Gates, February 13, 1913.
View of Flood Gates and Weir Control at Intake.

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EDITORIAL

DOLLAR diplomacy seems to have received its quietus in the announcement that the President has declined to reiterate the request of the former administration that American bankers participate in the Chinese loan. The probability that the machinery of the Federal government would be employed as a sort of glorified collection agency does not appeal to many people. The possibilities of development within the United States have not been exhausted. Why not have a little 'Dollar Diplomacy' at home?

NEWSPAPER reports of technical matters are a frequent source of amusement. This time it is the invasion of Pacific Coast oil markets by the Shell interests, which according to the report, will result in all sorts of dire happenings to the Standard and other companies now in the field. The description of the character of the Borneo oil is such, that apprehension, even alarm may well be felt. It states that "The Bornean has no use for 'tops' such as gasoline, which is obtained by skimming the oil, as cream is obtained by skimming milk." A careful reading of the article fails to disclose whether the wells from which this marvelous oil is obtained are Jerseys or Holsteins. We might suggest, however, that in the light of modern progress, cream separators would be more economical than skimming, even if native labor is both cheap and plentiful.

LEGISLATION regulating the production of coal, natural gas, and petroleum has been recommended by a conference of state geologists, representatives of the United States Bureau of Mines, state bureaus of mines, state mine inspectors, coal, natural gas, and petroleum well operators held at Pittsburgh on February 7, 8, and March 11, 1913. A report has been made outlining desirable legislation which may be drawn up in legal form in each state to meet special local conditions. The ground covered in the report includes provision for protective measures, the appointment of inspectors, and adequate penalties for the violation of the act. Legislation dealing with the oil situation in California is now receiving attention at the hands of the California State Legislature; a bill introduced by Mr. W. A. Sutherland was discussed in the editorial section of *Western Engineering* for January.

SCENES at the opening of the Los Angeles aqueduct from the frontispiece for this month. The intake gates were opened at four minutes after two, on Thursday, February 13, 1913. At a signal from William Mulholland, chief engineer, the four great radial intake gates were opened by eight men. At the gates were Messrs. William Mulholland, H. A. Van Norman, J. B. Lippincott, Charles H. Lee, Roderick Mackay, William W. Hurlbut, Frank G. Henderson, and George Shuey. The water finds it way through 21 miles of unlined canal with a grade of 1 foot to the mile, then through 40 miles of lined canal with a grade of 0.00015 to the Haiwee reservoir which is 61 miles south of the intake, and has a capacity of 63,800 acre feet. Here the wa-

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ter will be stored, and during the first part of May the gates of the outlet tower will be opened and the water will find its way through 100 miles of covered conduit, 12.5 miles of siphons, and 48 miles of tunnels to the Fernando reservoir situated on the north side of San Fernando valley, and having a capacity of 25,000 acre feet. From this point the water will be carried to the city and other points of distribution.

ESTABLISHMENT of a community of interest is held by advanced thinkers to be the solution of many of our sociologic and economic problems. The phenomenal success of the Carnegie Steel Company as an organization is a striking example of the practical operation of this principle. The opportunity to become interested as stockholders was extended to the great majority of employees, and the result is now a matter of history. Mr. John H. Lewis, in his article published in this issue, has brought out an interesting suggestion for the extension of this principle to the solution of many of the vexed questions entering into irrigation and power development. Local conditions have in many cases militated against the unqualified success of the Government Reclamation work as far as the rapid and successful development of hitherto waste lands was concerned. A plentiful supply of water is essential, but is by no means the only requisite to successful farming. Mr. Lewis, in discussing conditions in Oregon, brings out the fact that only 7 per cent of the increase in irrigated acreage between 1892 and 1909 was due to the operation of the United States Reclamation Act, the Carey Act, and the Irrigation District Law. Commercial enterprises were responsible for only 11.3 per cent, while the balance, or 81.7 per cent was due to individual effort or coöperative enterprises, in spite of the many handicaps to which such operations are subject. The conflict between vested interests and Government enterprises has been in a large measure responsible for retarding growth and settlement under the Reclamation Act, while the interests of the state are often a third party in the controversy. A case is now being fought out in California over the conflicting claims of the Reclamation Service, the private power and land interests, and the state over the use of the waters of Lake Tahoe. Mr. Lewis suggests coöperation between state, nation, and private interests in the development of irrigation and power projects, the state to act as promoter and thus save to settlers the large share demanded by the private promoter and capital for the flotation of such enterprises. The money advanced would be in the nature of a loan and constitute a lien upon the land or power project developed, thus securing development without increasing the burden of taxation. The problems growing out of the divided control of undeveloped land could be solved by establishing a community of interest between the nation, state, vested interests, and the settlers. Mr. Lewis' paper sheds new light upon the question, and will well repay careful study.

Leasing Oil Lands

Elsewhere we print the tentative draft of a report of the Mining and Metallurgical Society of America on the subject of leasing the government owned oil lands. For the benefit of those of our readers who are not members of the Society we may say that it includes in its membership many of the successful mining engineers and

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metallurgists of the country. While not a large institution, it is influential. As relatively few of its members are engaged in oil production, their interest in oil land legislation is incidental to the general subject of the revision of the mining law. The crudities and deficiencies of the latter are as troublesome to gold miners as to oil men. The committee from the society engaged in consideration of mineral land laws, acting through a subcommittee took up the present unsatisfactory conditions of the oil land laws with the earnest desire to point out a means of promoting orderly development. In view of prevailing sentiment, it was not considered worth while to debate whether a leasing system is wise or is the best system that can be framed. Opinions differ as to this, but there is little room for disagreement that some such system is likely to be put into effect. That being so, it is the part of wisdom to shape the law to best serve the industry. The plan that is here outlined, frankly recognizes that the oil business, at least in the West where the public lands lie, requires large capital and experience; that no great good accrues to the public from encouraging claim stakers who must later sell to men really prepared to develop. The plan contemplates bringing the actual oil developers and the government officials into direct contact. Granted that there is to be a royalty, it allows each man to fix this for himself by estimating what he can afford to pay for a definite block of land and allowing him to make that the basis of his bid. Under the system no one would pay one cent except as it came from the ground, and each lease holder would be protected from changes or advances in royalty during the time of his lease. In short, the oil company would face only the risks of the business as now, and responsible parties would deal direct with the land owner, in this case the United States Government. Provision is made for larger grants in wild-cat than in proved ground, and a mild anti-monopoly clause, without which there is small hope of any legislation, is included. The plan has its good points and also its defects. It is at least constructive and consistent. It is frankly provisional, and is put forward for discussion. Some of the strongest men in the Society including those most experienced in the oil business, dissent from one or more features of the plan. It is, perhaps, going to require strong and united efforts to prevent enactment of ultra theoretical land legislation in the next few years. This is distinctly a case where discussion from those who know will be helpful, and we shall be delighted to give space to letters from readers of *Western Engineering*, who include among their number many of those best qualified to counsel wisely in this matter.

Engineering Organizations

Centralization of industries has been in progress for many years. The individual has been merged into the co-partnership, the co-partnership into the corporation, and the corporation into those gigantic aggregations of capital misnamed 'Trusts.' In a quieter, though no less effective way, a change gradually has been taking place in the status of engineering professions. Fifty years ago, the engineer hung out his shingle and practised his profession on the same basis as a doctor or lawyer. He hustled for retaining fees, made reports on projects of one kind or another, and was independent. Today, the majority of engineers are salaried employees, taking their pay checks from large cor-

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porations, and making obeisance to the time clock four times a day. Even in what is left of the consulting field, the work is done by the engineering corporation rather than the individual. Many of these look upon the engineering portion of their work as little more than incidental. It is merely a means to an end, a stepping stone between an undeveloped natural resource and 6-per cent first-mortgage bonds, preferred stock and similar awe-inspiring 'securities' with which most of us, unfortunately, have little more than a bowing acqaintance. An engineering corporation that can examine a project, determine its engineering and economic possibilities, finance it, handle the construction work, and then manage it when it is ready to commence operations, certainly has a great advantage over any individual practitioner. The existence of such concerns, and there are several in the United States, makes it exceedingly difficult for the individual consulting engineer to obtain a foothold. It is the case of the 'Trust' and the small independent competitor over again. The question is, are such organizations of benefit or a detriment to the welfare of the community? From the investors' side, they are a decided benefit. They adequately guarantee both the engineering and the economic features of any project they may undertake. They become responsible for the production of earnings by assuming the management. There is neither division nor evasion of responsibility. If the project is not successful for any reason, the blame is fixed, loss of prestige and credit follows, and the once great engineering corporation is automatically shelved as far as future business is concerned. We do not mean to imply that there is danger of monopoly in the practice of the engineering profession. On the contrary, it would be a strange economic law indeed that did not extend its influence in all directions. Is it not better to recognize the existence of conditions as they are, take a leaf from the book of the successful engineering organization, and 'Do as the Romans do'? The recognized ethics of the engineering profession place a limit upon the extent to which the engineer may go in soliciting business. Display advertising puts the stamp of quackery upon the engineer as effectually as on the doctor or lawyer. Codes of ethics recently adopted by the engineering societies permit the use of professional cards only. In oral or written solicitation, whatever degree of confidence a man may have in his own ability, propriety demands modesty when the personal pronoun is called into requisition. A partnership or an engineering corporation, however, possesses many advantages in this respect. A member of a firm, for instance, may be as eloquent as he pleases over his partner's ability and fitness for the work solicited. This is only one of the many advantages of combination. Office expenses are divided; earnings, it is true, are also divided, but the good will, knowledge, and circle of acquaintances of the various members of the firm are combined so that each partner supplements the work of the other and all increase individual earning capacity. Taking unto oneself a partner, however, is not to be approached lightly. It is a matter calling for circumspection and care. Temperamental differences may nullify the highest technical ability. A mule and a horse do not work well in double harness, though each, individually, has a great sphere of usefulness. So it is with men. First know thyself, then know thy partner, beforehand. Afterward will take care of itself.

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REVIEW OF THE MONTH

AMERICAN politics is a frequent source of wonderment to our European neighbors. A president goes, a president comes; a simple, dignified ceremony is carried out, and a new administration is installed. At home we are so accustomed to the process that we at once pass to an interest in details. Newspaper prophets are busy speculating upon the course that will be pursued by the new party in power. While the platform upon which Mr. Wilson was carried to victory is more specific than is usual with such declarations, interest centres upon the actual working out of the plans. An extra session of Congress has been called for April 7, and the cost of living will have an opportunity to 'view with alarm' the revision of the tariff downward.

CALIFORNIA hopes for better treatment from the new Congress, with regard to the Government exhibit at the Exposition, than was received from its predecessor. After it became certain that the Rodenburg bill could not pass, an appropriation of $500,000 was provided in the form of an amendment to the sundry civil appropriation bill. This bill passed both the Senate and House, but was vetoed by the President. His action was not taken through any disapproval of the Exposition. On the contrary, Mr. Taft has warmly advocated the idea since its inception. An obnoxious piece of class legislation embodied in the bill, and exempting labor organizations and farmers' associations from prosecution under the Sherman anti-trust law, was the cause of executive disapproval. Mr. Taft's course will be heartily applauded by all lovers of justice, while the failure of the Government to make an appropriation for an exhibit at the Exposition may prove not to be an unmixed evil after all. It is hardly possible that the Federal Government will not participate in the Exposition, and an appropriation of $500,000 would have been wholly inadequate to meet the obligations that would devolve upon it as the host of foreign nations. There can be no doubt that the present administration will view the matter in its proper light and make an adequate appropriation within the coming year.

HETCH-HETCHY as a source of water-supply for the city of San Francisco has gone into temporary eclipse. Mr. Walter Fisher, during the last days of his administration as Secretary of the Interior, denied the city's application for a permit on the general ground that such a permit should properly be the subject of legislation on the part of Congress. Now that the first disappointment over Mr. Fisher's action is over, it cannot be denied that there are excellent grounds for his opinion. Such powers as are vested in the office of Secretary of the Interior with regard to lands under control of the Federal Government are subject to execution according to the whims and fancies of every new incumbent in office. San Francisco's experience thus far speaks for itself. Mr. Franklin K. Lane, of California, the new appointee, whose past advocacy of the Hetch-Hetchy project bespeaks his friendly

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attitude, has expressed views that coincide in the main with those of Mr. Fisher. Mr. Lane has promised to recommend that Congress grant the necessary permit, and it will rest with the California senators and representatives to carry the matter through to a successful conclusion.

TRANSPORTATION affairs with regard to the Exposition have not made much progress during the past month. A possibility has arisen that a suit for an injunction may be brought by the United Railroads to prevent the construction of tracks previous to April 22, when the joint-use agreement will be submitted to the voters of San Francisco. The officials of the United Railroads state that they have no desire to prevent the Geary Street Railroad from extending its lines from the present downtown terminus to the ferry, but as it is possible that the project may fail of ratification by the voters, the United Railroads is justified in protecting its legal rights. While the contract for the construction of track on Market street between Kearny and Sutter streets has been awarded by the Board of Public Works, it is likely that it will not be signed until after the election. In the meantime, the bill introduced in the State Assembly authorizing the Board of Harbor Commissioners to extend the Belt Line Railroad through Fort Mason to the Exposition grounds has been passed and now goes to the state senate for final passage before being submitted to the Governor for his approval. The question of adequate transportation facilities is complex and possessed of many angles. As the plans suggested by Mr. Bion Arnold and now being investigated by the city engineer seem to present the only solution to the difficulty, it is to be hoped that nothing may occur to prevent their consummation.

EVERY little merger may have a dissolution all its own, but every little dissolution does not have a California Railroad Commission to face. After the disapproval by the Commission of the terms of the unmerging scheme first submitted by the Union and Southern Pacific interests with regard to the control of the Central Pacific, the plan was abandoned and a new one presented. On the face of it, the new plan provided for the lease to the Southern Pacific of the Central Pacific line from Tehama to the Oregon boundary; the sale to the Southern Pacific of that part of the Central Pacific line between Weed and Klamath Falls which is within the state; and the lease to the Union Pacific of all the other property of the Central Pacific in California. Attorneys for the Western Pacific were interested spectators at the hearing, and by several questions conveyed the impression to the Commission that all was not as it seemed, and that part of the new plan was being withheld. This view was confirmed in a published statement by Mr. Krutschnitt, telegraphed from New York, to the effect that the new plan, with a few minor changes, was substantially the same as the one first proposed. The Commission has gone on record to the effect that no retreat would be made from the position that was taken in the first instance, namely, that whatever rights might be granted by the Southern Pacific Company to one competitor must also be granted to all others on equal terms. Further details of the second plan showed an exclusive traffic agreement as a substitute for a trackage arrangement which, in effect, was merely a dis-

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tinction without a difference. A combination through dissolution would have been quite a feat of legal jugglery, and this, in the opinion of the Commission, seems to have been what both plans were designed to accomplish. At any rate, the California Railroad Commission has proved to be the barrier in the way of its accomplishment. Announcement has been made by the railroad officials that the second plan has gone by the board, and that some new way must be devised that will meet the exigencies of the case and comply with the ruling of the California Commission. An interesting side light on the situation lies in the statement that Kuhn, Loeb & Co., of New York, had underwritten the stock distribution features of the dissolution, and that by the terms of the agreement between the Union Pacific and themselves, the former were to forfeit $1,250,000 in case the second plan offered should not be approved. In view of the fact that Kuhn, Loeb & Co. lent their financial backing to Mr. Harriman when the merger was first consummated, and are said to be heavily interested in Union Pacific securities at present, it seems like taking money out of one pocket to put it into another. We cannot do other than wonder if the forfeit really will be paid. Mr. William Sproule, president of the Southern Pacific Company, has announced that under new dissolution plans about to be presented, the Southern Pacific Company will retain the Central Pacific interests in their entirety. As the Southern Pacific has owned the stock of the Central Pacific outright for many years, this will appear to many as the logical solution of the question. The plan first submitted and approved by the former Attorney General, Mr. Wickersham, whereby the Union Pacific acquired the Central Pacific, was widely considered to be prejudicial to Pacific Coast interests and unfair to the stockholders of the Southern Pacific Company. That the plan failed is due to the action taken by the California Railroad Commission.

RAIL transportation of oil within the state of California is becoming less every day. Production is increasing at so rapid a rate that the railroads have been at their wit's end to provide rolling stock to relieve the congestion. The latest arrival among the large producers, the General Petroleum Company, is reported to have effected an arrangement with the Southern Pacific and Santa Fe railroads whereby another main pipe line will be added to the already large number now in service. The pipe line will be constructed by the General Petroleum Company, from Bakersfield over the Southern Pacific right of way over Tehachapi pass, terminating at Mojave. While the price at which the oil is to be piped has not been disclosed, it will undoubtedly achieve a material saving over that of rail transportation. It will also release a large quantity of rolling stock, thus relieving the congestion elsewhere, and will also make unnecessary the contemplated expenditure of $5,000,000 for double tracking the line over Tehachapi.

WITH this issue begins the second year of publication of *Western Engineering*. The first milestone has been passed; the theories of the publishers have been put to the test. We believed that the growing importance of the West as a field for engineering development warranted the publication of a technical paper devoted exclusively to that field. The gratifying support that has been accorded our venture has justified this belief. A year ago *Western Engineering* was a theory; to-

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day it is a fact. The status of a technical publication is determined by the professional standing of the men who contribute to its reading pages. In this respect, *Western Engineering* has been especially fortunate. It has enlisted the coöperation of men whose work has placed them in the front rank of their profession. To these men is due primarily the measure of success that has been achieved, and we take pleasure in thus acknowledging our debt. There are four parties intimately concerned in the success of this enterprise; contributors, subscribers, advertisers, and publishers. The contributor is concerned in knowing that the ideals of the publishers are in accord with his own, and that the readers are of a class intellectually capable of understanding and appreciating what he has written, and applying the knowledge thus gained to the benefit of the profession at large. The subscribers are the complement of the contributors. They form the tribunal before which *Western Engineering* appears for judgment each month. Their comments and suggestions are the stars by which the publishers guide their course. *Western Engineering* has one aim; to give its subscribers what they want. And, Mr. Subscriber, if you don't see what you want, ask for it. The advertiser is no less concerned than the contributor or the subscriber. The same factors that influence contributions or subscriptions make *Western Engineering* a desirable medium in which to advertise good wares. An effective advertising medium must come before those who are interested in the commodity advertised. Mere bulk in a subscription list does not signify. Effective circulation is what really counts. It would be incongruous to advertise power apparatus in a fashion paper, although many of them number their subscribers in the hundreds of thousands. The best *prima facie* evidence of the value of *Western Engineering* as an advertising medium for engineering apparatus is the character of its reading pages and the professional standing of the men who contribute to them. Printed matter of this kind is not filed in the waste paper basket after a hasty glance. It is read, studied, and then carefully filed and bound for reference. Efficiency does not apply to engineering alone, but to advertising as well. The publishers are the fourth party to the transaction. Theirs is the work, mental and mechanical, necessary to collect, compile, and dispense the matter that makes up the paper. Theirs is the financial risk, and theirs the direct financial loss or gain. Rome was not built in a day, neither may a technical publication be. We like to think of the community-of-interest that dominates a publication of this kind. The contributor who achieves a difficult piece of work, or conceives a new idea through research or investigation, makes it public through the technical press. His knowledge of the subject is thereby given wide circulation, and clients who may have similar work to be done are directed to the author through the medium of publicity. The subscriber has the benefit of the collective knowledge of hundreds of specialists. This knowledge he may apply to his own needs. It is give and take, pure and simple. The advertiser helps the reader by keeping him posted as to the development of apparatus, and helps himself by stimulating the sale of his product. The publisher can prosper only to the extent to which he helps his patrons, and by patrons we mean contributors, subscribers, and advertisers. Service is what counts, and it is upon this foundation that *Western Engineering* is built.

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Electricity in the Oilfields

By H. A. RUSSELL*

IT has been asked why the electric motor was not brought sooner into the oilfields for performing the various operations necessary to the production and handling of oil. Until recently, the field was not promising in revenue for either the power producer or the manufacturer. When oil was first pumped in merchantable quantities, methods adopted were those followed in the older fields, and the steam engine became the standard motive power; the oil man knew just what it would do. He duplicated the oil rig of the older fields in every particular, as to the size of engine, manner of mounting it, and the way of handling it. An electric motor should perform all the functions of the engine and be a prime mover proved to the oil man's entire satisfaction before he would give up his time honored engine. Until such a machine could be produced, the power company did not look upon the oilfields as a profitable place to spend money in line extensions. Several years ago a motor or two were tried in oil work, but they were stock motors, not built for the work, and they showed no advantages for electricity over other means of drive. It was not until about two years ago that the electric manufacturer began seriously to invade the oilfields. The electrical engineer had to solve two problems, that of drilling and of pumping. His only precedent for such work was in the West Penn oilfields of West Virginia, where operators had been using a constant speed motor for pumping and had done little or nothing in the drilling line. This experience was of little benefit to the California oil man, as the conditions in the West Penn fields are entirely different from those found in California. The manufacturer was told that if he could duplicate the working of a steam engine, his motor would be a success. It is hard to tell what a steam engine will do when compared with a motor. The oil man will put up with shortcomings in the steam engine, but when it comes to using a motor it must do all that the engine did and a little more for good measure. It was therefore necessary for him to study the duties of a motor.

Duties of a Motor.—For pumping oil, it should develop about 5 hp. for 24 hours in the day at a low speed to produce about 20 strokes per minute of the oil-rig walking beam. If a motor had no more than this to do, the engineer would not find it necessary to design a motor for oil-well work. In Californian fields, however, sand gets in, the oil-level raises and lowers, which makes it necessary to vary the pumping speed. The walking beam works at 18 strokes per minute in some cases and as high as 30 in others. This means that a motor running at about 600 r.p.m. must be capable of varying its speed 40%. At times it becomes necessary to take out the rods, tubing, and otherwise manipulate pumping or drilling tools

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at points far below the surface where only the oil expert of long experience can diagnose the trouble and tell how to overcome it. For this, a hoisting motor is required of fine speed adjustment and of ample torque and running capacity to do its work quickly. When 'cleaning,' the motor should have about four times the capacity necessary for pumping and twice the speed, and it might be called a 'Jekyl and Hyde,' for it works in a dual capacity. It must perform these duties, and its cost of installation as well as the cost of operation must not exceed that of the steam engine.

Shaking Up.—One reason why the speed of a pumping motor should always be under control is the necessity of 'shaking-up' a well, which requires double the pumping speed. Where a variable-speed motor with an economical speed is used, a very good expedient is lagging the bull-wheel to increase the speed for cleaning. This, however, does not help the operator when sand gets in and he wants to shake up his well. To increase speed for this purpose he must still resort to changing pulleys or gears. When sand comes in, it is very important to clear it quickly if possible. This may be accomplished by running the pump at double its normal speed for pumping oil. If the well is shut down for a short time, say long enough to change the pulley, the well may in the meantime sand up and thus necessitate pulling the well, an all-day, expensive job and necessarily entailing loss in production. Another drawback and loss of time in shaking up is that after the well is cleared, sand may come in and do its damage in the interim between changing from the shaking-up pulley back to the regular pumping-pulley. The shaking-up operation may become necessary several times in a day and may only last for a few minutes, less time than it would take to change a pulley or increase the speed by any mechanical means. This is a feature that the General Electric engineers held constantly before them in designing the two-speed motor. With the two-speed variable-speed motor, speed is increased by throwing a switch, and, after shaking up, the switch is thrown back and the former pumping speed resumed, losing no time in the operation.

An experimental motor was installed on the Sherman lease of the Pacific Light & Power Co. near Los Angeles. This was a 20-hp., 1200 r.p.m., variable-speed, 440-volt motor, known as General Electric Co. type 'M.' It was found to be satisfactory in every way for cleaning, and easily took care of a 'wet' hole, pulling rods, tubing, and oil all at once, showing ample capacity for its work. For pumping, it was necessary to change the pulley to get reduced speed, and it was also found that when running at one-quarter its rated load, it gave very poor power-factor. Power-factor,† by the way, is the *bête noir* of all power consumers who are having their first experience in electricity. They never know what it means. It is current consumed by a motor, but does no useful work; it uses up the capacity of the power company's apparatus without rendering a revenue therefor. It heats the motor without producing power. We soon discovered by applying a different connection to the motor, that is, running it in 'delta' for cleaning, and, by means of a throw-over switch, connecting it in 'Y' for pumping, the power-factor would be much improved. The sample motor tried resulted in an order to equip 8

†An excellent description of power-factor will be found in February *Western Engineering*.

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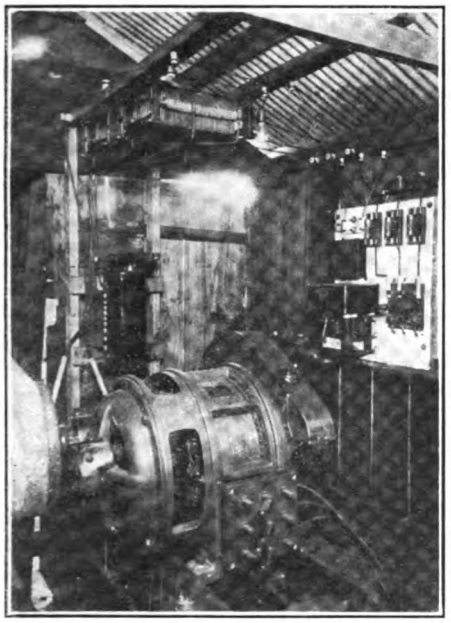
wells on the Sherman lease with these 'Y' delta, form 'M' motors, the first permanent pumping installation made in California. These motors are running today and apparently are in as good condition as when first put in.

The first permanent installation made in the San Joaquin valley fields was made by the General Electric Co. on the lease of the British Consolidated



BACK-GEARED GENERAL ELECTRIC MOTOR WITH Y-DELTA SWITCH, AT BRITISH CON. OIL CO., LTD., COALINGA, CALIFORNIA.

Oil Co., Ltd., at Coalinga, and the illustration shows a back-geared motor with the 'Y' Delta switch mounted on it.

These motors have been in continuous service ever since, giving satisfaction equal to those on the Sherman lease. A wattmeter is installed with each motor, and its performance is noted each day by the wattmeter readings. By this means, the operator is enabled to detect any increase in power or other irregularity in the performance of a certain well, search out the trouble, and correct it.

Speed Reduction and Transmission.—An incidental problem for the engineer was that of speed reduction: whether to do this by means of back-gears on the motor or separately mounted countershaft and pulleys. A majority of installations that have been made have used the countershaft, but the back-geared motors originally installed, notably those of the British Consolidated and Kern River oilfields where fifty motors were installed, are doing good work today. For shaking-up the well, or in fact changing the speed for any reason, by changing pulleys, is a very objectionable feature, and for both drilling and pumping a speed-changing gear was devised. I consider this to be an expensive addition to a pumping outfit, and one not of great practical use. Many oil operators have found that any mechanical speed-changing device that involves trouble in handling or entails a loss of time, will not be used. I have seen cases where a drilling rig was equipped with a three-speed gear-box, and in a half day's work, although requiring the three different speeds, the gear was not changed once. The operator found that he could get nearly the speed variations he wanted with the motor controller, although not economically, and did not care to bother with the gear-box. It is a nuisance to change pulleys, and the oil operator does not change them if he can avoid it. It therefore became evident early in the game that various speed requirements must be accomplished through electrical control. The first motor designed by the General Electric Co. for this work was a multi-speed induction motor getting its variation of speed by rotating a secondary stator, thus doing away with resistance, controller, and all sparking. However, as sparking, such as comes from the collector-rings of a

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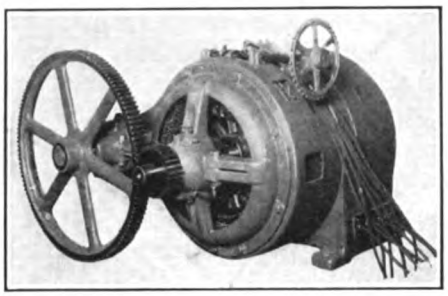
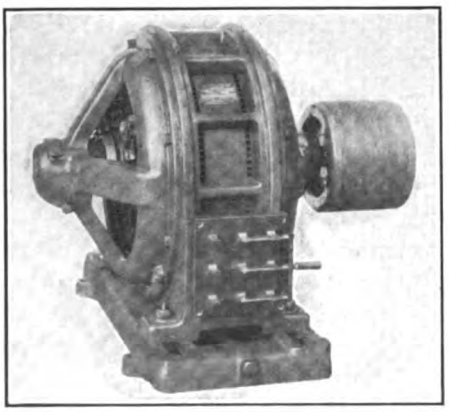
motor, was not found to be seriously objectionable, this motor gave way to the two-speed variable-speed motor, which has become very popular and is used in large numbers in the Midway



MULTI-SPEED GENERAL ELECTRIC INDUCTION MOTOR FOR OIL WELL SERVICE.

and Coalinga fields. It operates as a 7-hp. motor at 600 r.p.m. for pumping, and by throwing a switch on the motor it becomes a 20-hp. 1200 r.p.m. for cleaning purposes. By use of the controller operated by a hand-wheel at



TWO-SPEED VARIABLE-SPEED GENERAL ELECTRIC INDUCTION MOTOR.

the 'headache post,' any speed may be obtained between 300 and 1200 revolutions per minute. The motor has high efficiencies throughout its range of operation, and good power-factor as well. The price is moderate compared with steam or gas drive, and it therefore fills the requirements of manufacturer, power-producer, and oil-operator. These motors have been designed for a rating of 20/7, because it was understood at first that the average well took about 5 hp., and by allowing 7 hp. the motor would be ample for all pumping operations. Three times the pumping, or 20-hp., was considered sufficient for cleaning purposes. Some wells, however, have been found to require more than the 7 hp., and although the depth of the well does not necessarily fix the power required, it is apparent that larger motors will be necessary. The General Electric Co. has in course of construction motors of 25, 30, and 50 hp. for the pulling side.

These motors may be belted to a countershaft and thence to the large pulley, or in case of displacing an engine, the old engine may be used for the countershaft, as shown in installation for the United Oil Co. at Fellows. The Fellows installation also shows the standard practice of mounting the main oil-switch near the motor and running the wires through conduit to a sheet-iron case that contains the disconnecting-switch and fuses. This makes a substantial construction, both electrically and mechanically. The motor for pumping has come to stay, for it is easily handled, takes little room, and the cost of pumping is about half of that when steam-engines are used. Electricity is but a means of transmission, and when one looks over the forest of derricks, with puffs of steam like immense ostrich plumes coming from each one of them, one may realize the great loss both in generating steam in small units and transmitting it to the wells.

Drilling.—A number of drilling rigs have been used having 50 and 75-hp. motors and speed-changing gear-boxes. These motors have given the best of

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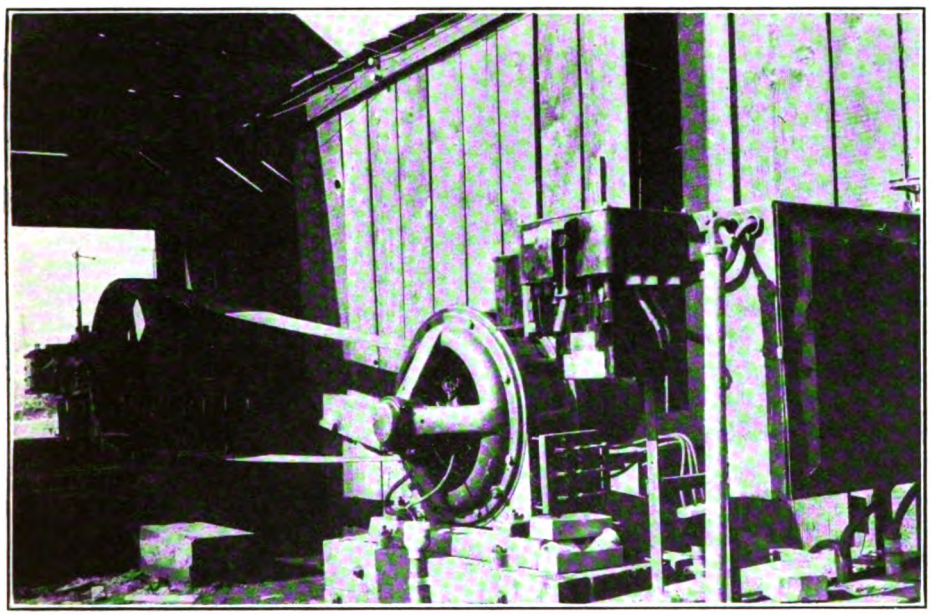
satisfaction. Several wells have been put down a depth of 1500 ft. in 30 days, and drilling rigs are now in use by the General Petroleum Co., Reward Oil Co., and others. Up to the present time, standard motors with mechanical speed-changing devices have been used, but the General Electrical Co. has a drilling-motor similar to the pumping-motor having two speeds—for 50/25 hp., and a larger size for deeper wells, 75/37½ hp. The only criticism from the operator of the drilling-motor has been that on the first ones installed, the speed control was not fine enough. In the Eastern oilfields, wells are drilled with a hemp rope, and as they go down the flexibility of the rope makes necessary exact speed control, so as not to catch the tool on the rebound, the motor lifting the rope while the tool is descending. In California, this trouble is not so great where drilling is done with steel cable, but still, accurate motor-control is very important. The first motors put out were equipped with standard 10-point controllers; this could control the motor speed from 450 to 900 r.p.m. in jumps of 45 revolutions. As this control was not fine enough, later installations have been supplied with an auxiliary controller of 10 points, designed to cut in between points of the main controller. For instance, say we require a motor speed of 842 revolutions. With the main controller we bring the speed from 900 to 855, then with the auxiliary we cut in three notches, bringing it down 13 revolutions more, giving us 842. The main controller is used for ordinary operations, and the auxiliary is only cut in when a very particular speed is required. Some wells have been drilled without making use of the auxiliary at all, but when very deep wells are drilled it will probably be found desirable, if not absolutely necessary.



INSTALLATION OF THE UNITED OIL CO. AT FELLOWS, CALIFORNIA, SHOWING OLD STEAM ENGINE DOING SERVICE AS A COUNTERSHAFT.

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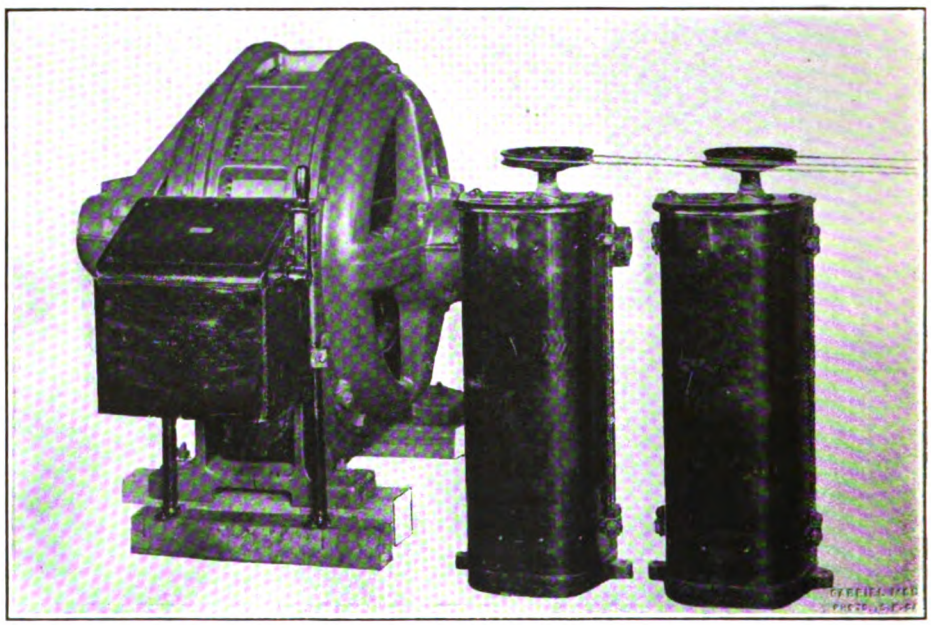
Where the flow of oil in the well is small and constant, the well may be pumped by jacks which are common in the older districts. The jacks are driven by standard, constant-speed motors of 20 to 50 hp., and the pumping is easily accomplished. The cleaning is not so easy. In such cases it is desirable to have portable cleaning rigs to visit the wells when occasion demands. Several of these portable rigs have been devised; one is used by the Kern River Oilfields, Ltd.‡



50/25-HP. GENERAL ELECTRIC DRILLING MOTOR, VARIABLE SPEED, WITH STANDARD AND AUXILIARY 10-POINT CONTROLLER.

Cost of Operation.—With a maximum charge of 1½c. per kilowatt for current, from observations thus far taken, the cost of pumping will not average over $1 per day. In the Coalinga fields, reports of eight companies with pumping-wells about 1600 ft. deep, the cost per month ran as low as $22 and as high as $39. Other reports give costs of only 40 to 70c. per day. This means that it costs the operator for power about ¾c. per barrel pumped. The cost of drilling is largely a matter of luck with the operator. I have known wells to be put down in 30 days, and others, where trouble was encountered, to take twice that long. The cost, as reported thus far, has ranged from $1.50 to $6 per day. On the whole, it might be said that the average well of 1600 ft. can be put down within 30 days at a cost for power of $60.

The motor will do all that the steam-engine ever did, and more too. The motor, however, is like a too-willing horse in some respects; it will allow itself to be overloaded and will try as long as it can hold together to get away with the load. This brings on ruin. The engine quits before that point is reached, and lets you know that you are calling for more than it can stand. It is therefore necessary to

‡See *Western Engineering* for March, page 200.

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put protective devices on the motor, and for a two-function motor there is a two-function protective device; that is, there are overload relay-coils which protect the motor when working under 5 hp. for pumping, and when the switch is thrown over, this double coil is thrown into position to protect the motor for its 20-hp. drilling and cleaning load. I believe the two-speed motor, as described, to be the ideal machine for oil operation. It is meeting with favor where the operators become familiar with it, and considering that after practically two years' experience it is replacing the steam-engine that has been a faithful servitor for the past twenty years, I believe that the steam puffs in the oilfields will become smaller and beautifully less from now on.

Co-operation Between the State and Nation in Irrigation and Power Develoment*

By JOHN H. LEWIS†

THE Reclamation Act and the Carey Act were framed by Congress to promote the irrigation of vacant public lands in the Western states. Some of these states, such as Oregon, have been unfortunate in having much of their vacant lands, in the vicinity of feasible projects, taken up by settlers, not for the purpose of raising crops by dry-farming methods, but primarily to raise prices when their lands were subsequently included in an irrigation project. This early settlement has, in general, been a detriment to Oregon, although a great help to the entire West through the swelling of the Reclamation Fund. It has made impossible the reclamation of these lands under the Carey Act, and greatly complicated their irrigation under the Reclamation Act. We in Oregon are therefore anxious for some amendment or extension of these laws to encourage the reclamation of lands which are almost exclusively in private ownership. The rainfall in many of these districts is so meagre that in many cases the entryman has abandoned his claim immediately upon receiving title from the Government. This settlement has thus added but little to the population or taxable wealth of our state.

Irrigation.—The coöperative stream surveys which have been in progress for some years disclose the fact that 10,700,000 acre-ft. of water is available, in eastern Oregon alone, for diversion or storage for irrigation purposes. Of this amount, 6,800,000 acre-ft. is available for utilization on known projects which are generally considered as feasible. This amount of water is sufficient to irrigate 3,000,000 acres, in round numbers. The area irrigated at the present time is only 606,000 acres. With these enormous possibilities, our people are not disposed to sit quietly by and watch our sister states develop more rapidly through irrigation, and thus support a population ten to twenty

*Read before the National Irrigation Congress, Salt Lake City, Utah, October 2, 1912.
†State Engineer of Oregon.

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times as dense as can make a living on our dry-farming areas.

Power.—These surveys have disclosed another startling fact. We have, in the streams of Oregon, 3,300,000 hp. which is undeveloped and going to waste. To produce this power in steam-engines would require the annual consumption of coal valued at $224,000,000, figuring 17 tons per hp.-year and coal at $4 per ton. This power, if developed and furnished to our people at cost, would stimulate development fully as much as irrigation. The cheapest power is generally obtained through the construction of the largest projects. These are invariably beyond the reach of the homesteader, the average business man, and the average municipality, and so far have not been touched by private capital. They are still in the control of the state or the United States.

Much of this power can be developed incidental to the construction of the irrigation projects mentioned above and without competing in any way with private capital already engaged in the power business. In fact, such development would benefit existing companies. On some streams, such as the Columbia river, the floods occur at the time when large quantities of power are needed for the pumping of water for irrigation purposes and when other streams are at their lowest stage. The surplus summer power could be sold to private companies now operating on these other streams. These companies could develop large quantities of additional power during the flood-water period in the winter months. In this way the power value of different streams could be equalized without the construction of reservoirs, which in many cases is not possible.

Cost of Power.—We are beginning to appreciate the value of this power. The annual cost of 24-hour power produced in ordinary steam-engines ranges from $40 to $180, depending upon the size of the plant. Private electrical companies have only to meet the price of their nearest competitor. In Norway and Sweden the prevailing price of hydro-electric power, in large blocks, is from $5.40 to $13.40 per hp. per year. The province of Ontario, Canada, has for several years been transmitting power at cost. At the present time it is purchasing power from the private plants at Niagaga Falls for $9 per hp. per year, and is supplying 30 municipalities at $18 to $29.50, depending on the distance of transmission. Toronto, 90 miles from the falls, with 400,000 population, is furnished 10,000 hp. at $18.50 per year. The margin between cost of production and existing prices is thus very large, and the benefits to be derived from our greater water-power resources cannot be had by our citizens unless a combination is made for the construction of large projects capable of supplying many cities and towns, or unless the state, or the state in coöperation with the nation, comes to the assistance of its citizens, somewhat along the lines successfully followed in the province of Ontario, Canada.

The Problem.—To promote the development of these enormous irrigation and power resources, and incidentally the settlement and development of our state, is the problem which we have been endeavoring to solve. We believe that many Western states are somewhat similarly situated, and that a united effort may result in some solution of the problem. Both the United States Reclamation Act and the Carey Act have proved disappointing from the standpoint of placing settlers on irrigated lands in Oregon. Also, the anticipated development through the

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irrigation district law and by private capital operating on a large scale have likewise been disappointing, as shown by the recent Government census.

Only 7% of the increase in irrigated acreage in Oregon, between 1899 and 1909, was due to the three above-mentioned laws, while 11.3% was accomplished by commercial enterprises operating on a large scale. Both of these figures, however, are in striking contrast with the statement that 81.7% of the 300,000 acres increase during this decade was accomplished through individual effort or coöperative enterprises. This showing is all the more startling when it is remembered that no encouragement whatever was given the small water-user through the enactment of beneficial water laws until the last year of this period. He was left to wage an unending and unequal fight before the courts with his more wealthy rival, who was not holding the water for use, but for speculative purposes.

Difficulties.—The difficulties in harmonizing vested interests under the proposed Government projects in Oregon, as compared with other states having more vacant land, seems to be the reason for our disappointment in the Reclamation Act. Under the Carey Act most of our early projects have been reorganized or abandoned. The lack of complete engineering plans at the outset, the lack of complete financial plans, and the lack of experience on the part of both the promoter and the state in handling the enterprise and colonizing the lands, appear in general to be the reasons for this disappointment. A number of new projects with good engineering plans have been unable to enlist private capital where 100% profit over and above the cost of construction has been allowed.

To start an irrigation district requires the services of a persistent energetic promoter. Such men are scarce in the absence of some special interest. The legal entanglements of a long and cumbersome law, make operation in a businesslike way very difficult, under the district law. Private capital seems to have lost interest in large irrigation projects since it has discovered that it takes many years to complete and colonize a project. Capital invested in ordinary commercial enterprises is usually turned over several times each year with profit. Where money is tied up for years before closing out a project, the percentage of profit must necessarily be very high to attract capital.

So eager have we been for development that we have apparently forgotten the man who is to live upon the land and accomplish the real work of development. There is a limit to the burden which he can carry. When 82% of the increase in irrigated acreage in Oregon for the past decade has been accomplished through the individual effort of the small water-user, as compared with 18% by all other agencies, it seems high time that we do less for private capital and more for the water-user. The Government is now engaged in the construction of a 30,000-acre project in Oregon, containing a large percentage of public land, at an estimate cost of about $90 per acre. There are a million or more acres of private land which can be irrigated at about one-third the proposed acre-cost for such project. It seems illogical to expend public funds on such a project when the same money would reclaim three times the area of private lands. So far as the state is concerned, it makes no difference whether the new settler makes his home on public lands or on private lands.

The Remedy.—The only remedy we can see for this unfortunate situation

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is for the state to vote bonds for the construction of irrigation and power projects, the money when invested to be made a lien upon the land irrigated, and power-plants constructed to insure its return in 20 to 40 years with interest. In this way development can be secured without increasing the burden of taxation. In fact, such development should have a tendency to decrease state taxes. The state would then act as promoter, thus saving to the future settler the promoters' profits as well as the large profit to capital. The item of risk would be eliminated, as, whatever the cost, it should be assessed against the land. With the prospects of securing water at practically cost, the land-owners should not hesitate to mortgage their lands to insure the return of the state's money.

The Government has worked out a form of contract which gives the land-owner an opportunity to sell at a profit to anyone who will pay for the water when delivered, and which permits the Government to sell at actual cost of furnishing water, if the land-owner has not found a purchaser by the time water is ready for delivery. With the selling charges lowered, and with long-time payments and low interest charges, the colonization problem should be much simplified. To overcome the fear on the part of the people of the state in voting a large amount of money to be expended by inexperienced state officers, I would suggest that the state coöperate with the U. S. Reclamation Service. Some Government land is embraced in most projects, and besides, water-power developed incidental to irrigation construction can be transmitted by pumping to Government land in other parts of the state or to adjoining states. Further, the United States Government owns and has withdrawn from entry most of the land which is valuable for water-power development.

Such coöperation appears necessary, in view of our divided control of both land and water resources. It would make available to the state an organization which has already made a complete success in the construction of irrigation and power projects on a large scale. It would avoid numerous mistakes which are inevitable in the organization of a new department for a technical and complicated work. Coöperation with the United States would secure to the state the benefits of the civil service rules, thus avoiding the annoying question of politics about as completely as is possible under our present form of government. It would enable a comprehensive plan or policy to be carried out regardless of a change in views or politics on the part of either of the parties unless concurred in by both; it would create an organization so large that it could not be reached through bribery or held up like a weaker organization. The territory to be covered by its electric-power transmission lines is so great that no single water-power site would be absolutely necessary for its success. The state's coöperating officer would be always on the job to see that the methods and system of the larger organization fit conditions on the ground, and to prevent unreasonable delays. This system of coöperation by the states to secure the advantages and experience of technical branches of the United States Government is well understood. To carry out this plan will, I believe, require no further legislation on the part of Congress, unless it is to vote an equal amount of bonds in case of shortage in the reclamation fund.

I believe some form of coöperation in all internal improvements, such as river and harbor work, would be very desirable. It would have a tendency to elim-

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inate politics from the question of appropriations. It would prevent many useless appropriations. Oregon and the entire West would benefit if the United States Reclamation Act were amended so that funds could in the future be expended only in those states which would coöperate dollar for dollar with the Government.

For seven years the state of Oregon has been coöperating with the U. S. Geological Survey in stream gauging, water-power investigations, and the making of topographic maps. This year $56,000 is being expended jointly. No friction has resulted, and the work has been carried on more efficiently than possible by the state alone. This system should be extended to other branches of the service. The plan which is here suggested for a solution of the irrigation problem in Oregon is therefore not an untried plan. The Department of the Interior (U. S. Geological Survey, Washington, D. C.) has published a pamphlet entitled 'Coöperation between the United States and Various States in Topographic, Hydrographic, and Geologic Work.' This can be secured by anyone interested. The benefits derived by the various states through coöperation as outlined in this pamphlet leads us to believe that somewhat similar coöperation for irrigation work will prove equally beneficial for the various states.

Program in Oregon.—It has been proposed in Oregon that the legislature appropriate $50,000 for making detailed surveys, plans, specifications, and estimates of cost of one or two feasible projects, the money eventually to be returned to a revolving fund for the survey of other projects. This will be accomplished by authorizing the state engineer to file upon, or withdraw from entry, all unappropriated water necessary for the proposed projects, before beginning the investigations. The surveys to be carried on in coöperation with the U. S. Reclamation Service if an equal amount is set aside by the Secretary of the Interior for similar work in Oregon. At the same time it is proposed that the legislature submit to a vote of the people the necessary constitutional amendment authorizing the issuance of bonds for construction purposes, if private capital cannot be found to construct the projects in accordance with the state plans.

If the project is ultimately constructed through public funds voted in part by the people of the state, the first payment should be to reimburse the state for the full cost of surveys and investigations. This payment to be added to the ultimate cost of the project and made a lien on the lands benefited or power-plants constructed. If the people do not see fit to approve such a constitutional amendment, then the state engineer should be authorized to assign such water rights, or any portion thereof, and sell the plans and specifications to such persons or corporation as will reimburse the state for money expended thereon, and give the best assurance that the project or any unit thereof will be carried out at the least cost to the water users, substantially in harmony with the approved plans prepared by the state. In this way, public interest can be protected in such cases as where there are several small projects, the construction of any one of which might defeat or make difficult the ultimate construction of a larger project, or where the construction of one or two small power-plants might prevent the storage of water for irrigation, thus defeating the higher use, and one where the ultimate taxable wealth might be a thousand times the taxable value of the power-plant.

Under such a plan some assurance

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could be had by the people of the state that the waters of our streams would be put to the highest use. With the preparation of such plans, even though the people voted down the necessary constitutional amendment, I believe that an important step forward would have been taken, for the office of 'public promoter' would have been created. This public promotor would have the confidence of the people of the district, as he would have no financial or personal interest in the undertaking. He would save to the people the usually large promoter's profit. By having complete plans, specifications, estimate of cost, and water-supply data, competition for the construction of the project could probably be had from private capital, and the 'state promoter' assign to the one offering to construct upon the most liberal terms.

Private capital is constantly beset by promoters seeking support for projects which they have completely worked out perhaps through years of study, and in which sufficient profits appear to satisfy both the promoter and the capitalist. We have pointed out above, that in the construction of large irrigation projects there is usually but little profit for the promoter or for private capital. If there is an exorbitant profit to anyone, all interests cannot be harmonized, and therefore the project is defeated. Owing to the uncertainties of organization, the private promoter, as a rule, never puts sufficient money into engineering plans and investigations to work out the best project, and this we believe is the cause of the failure of so many private projects. Therefore, if these large projects are ever to be properly presented for the consideration of private capital, or for the proper consideration of the people in deciding upon construction with public funds, the state must undertake the promotion of specific projects.

Conclusion. — In conclusion, I am somewhat persuaded that the Lord helps those who help themselves. If the state is willing to vote bonds for the development of irrigation and power projects, I believe that Congress can be prevailed upon to vote an equal amount, for already $20,000,000 has been voted without coöperation on the part of any of the states directly benefited. Even if Congress should fail to coöperate, it would seem to be a business proposition for the state to issue bonds for the construction of feasible projects, somewhat in advance of the demand for settlement. Such action would increase the cost to settlers only by the slight difference in interest rate at which state or Government bonds could be sold. It should be kept in mind that money from the reclamation fund, invested in any state, is not a gift to that state. It must be paid back in time. Therefore, if this fund is inadequate, why should not the states directly benefited lend their credit to supplement this fund, with the understanding that the money advanced be returned eventually with interest?

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The Derivation of Oil-Well Logs

By ROBERT W. PHELPS*

A GREAT deal has been written on various subjects relative to drilling oil wells, but there is one point that seems to be invariably overlooked in technical papers as well as in actual practice, and that is the imperfection of well logs. Many times a small company, with one or two to a dozen wells, wishes to make use of its logs. After working them out from dust-covered drillers' time-reports, it is frequently found that the data on hand are neither complete nor comprehensive. Then, in future, more care is taken. On the other hand, drilling superintendents do not know what is wanted, other than in a general way, and are glad to get suggestions as to the data required. This article will touch on the derivation of logs, and not on their usefulness.

The elevation of each well at the derrick floor from which the drillers are taking measurements should be taken before the log can be considered complete. While it is best to have a sea-level datum, it is not essential, but the relative elevation of the wells should check within a foot; the variation in any case should not be greater than five feet.

The most essential details are those that can only be obtained while the well is being drilled. Details as to strata, their depth, name, and contents should be obtained from the driller daily on suitable drilling slips. Trusting to memory gives results that are unreliable and inaccurate. The superintendent should keep a supplementary log, which can include data left out by the driller. In no case should the log-slips be changed from the report of the driller. The depths and thicknesses of the various strata penetrated should be recorded by the foot. Recording closer than by the foot, especially after the drill has reached some depth, is unnecessary. It is easier for the driller to determine what the drill is penetrating with cable tools than with the rotary and the circulatory system, but with the 'stretch' of the cables it is folly to attempt to get depths closer than within 1 ft. With the rotary, just the opposite is the case. The driller can determine the depth of the hole within an inch, but he finds it difficult to determine what the drill is penetrating. Drillers should be made to report the full depth of hole. It is quite common to overlook this when those in charge do not appreciate the difficulties met by the driller and show impatience when conditions retard rapid progress in drilling. Such practice will result in inaccurate data concerning the depths of change of formation.

The formations all grade from one to another; that is, a shale grades to a sandy shale, the sandy shale to the sand, and the sand to conglomerate. The driller usually gets the latter name down all right, and it should remain as he enters it on the log. A point might be brought up here about the

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effect of changing logs to suit. The driller reports 'shale and boulders' or 'boulders in shale.' This report is much more frequent from a rotary log than cable tools. While boulders have never been seen in shale outcrops, and geologically it is most improbable, they should not be omitted from mention with the shale in compiling the log. In most cases these 'boulders' will tie up with shells or conglomerate in a nearby well. The boulders possibly

joys and troubles. When drilling for oil, the final object is to drain as many of the strata that contain oil as possible and with it a minimum amount of water; consequently it is just as important to enter water in the log as oil. It is also most desirable to note any peculiarities of the water; that is, whether it is hot, cold, sweet, salty, or sulphurous. Too much cannot be entered in the log along this line. Gas in the strata should not be neglected.

DAILY TOUR REPORT

Company	Lease	Well No.	Day	Date	Tour: Morning / Afternoon

FORMATIONS.

Depth from	Depth to	Formation	Color	Texture: Course	Texture: Medium	Texture: Fine	Hardness: Hard	Hardness: Medium	Hardness: Soft	Contents: Water: Dry	Water: Sweet	Water: Salty	Water: Sulphur	Water: Hot	Water: Cold	Gas: Amount	Gas: Gas	Oil: Barrels	Oil: Poor	Oil: Medium	Oil: Rich	Remarks.

CASING

Last casing put in hole: Size	Depth: From	Depth: To	Pipe now used: Size	Pipe now used: Depth	Remarks

Work Done

TIME

Driller	Hours	Tool Dresser	Hours	Remarks

might be hard concretions, but in ninety-nine cases in a hundred they are not.

The color of all strata penetrated is essential and should be noted. Often there is a streak of shale or sand that is of different color from the rest, and furnishes an excellent horizon, and therefore the colors furnish a great deal of information in correlating the formations of neighboring wells. Textures should be noted, as many important factors are determined by them. The same can be said in regard to the hardness of a stratum, and it is about the easiest thing the driller has to determine. The contents of all strata should be most carefully noted, as it is the contents that cause the company its

Oil is seldom omitted from a log, but I have seen a number of logs of producing wells that did not indicate a 'showing' and upon later investigation found that considerable oil was seen by the drillers.

A complete casing record should be kept. The exact position of each casing; the method in detail used in landing, and, if used to shut water off, its success; the number of perforations and how perforated; the initial production, gravity, and percentage of water and sediment; all should be noted by the foreman. None of the above details for a well log are superfluous, but are essential to the future development of any California field. It will be admitted

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that to get all of such data is difficult, but not impossible, as several of the largest operators in the state require it and are successful in their efforts.

Probably the greatest difficulty is due to the form of the drilling-slip, which usually provides for a modest little memorandum on 'change of formations' and leaves it to the driller to tell what he thinks necessary. It would seem advisable to have conspicuous blanks for each detail required, and to see that they are faithfully filled out from the surface of the well to the bottom at the end of each tour, and with as little writing as possible. The illustration gives a suggestion for a daily drilling and time-slip to be handed in at the end of each tour. These should be made up in books, so that the driller can keep a carbon copy at the well, removing the original to be forwarded to the office.

The depths, formations, and colors should be written in. The textures and hardness can be indicated by checking in the proper column. Under the water column one or two checks will indicate whether the formation is dry or contains water with any of the common variations. The same is to be followed out under the gas and oil columns. As there are many things that cannot have special spaces, these should be noted under 'remarks.' For instance, seashells are of great importance in establishing horizons, and, when a geologist is employed, fragments and the depths at which they were found might be the key to the solution of a problem. The casing blanks should be complete on each slip. Quite often work is done with the casing that is not plainly indicated when it comes to compiling the log. It might be suggested that, when any work has been completed with the casing, such as landing a casing, the foreman in charge send in a special form of a slip, spaces to be filled or checked, these slips to be the same size as the regular drilling slip so as to facilitate subsequent filing. In making the above suggestions as to the data that are wanted, it should not be construed that a sixth sense is expected, but the honest opinion of the drillers should be given of the strata penetrated and conditions encountered in drilling.

Water-Power Resources Tributary to Salt Lake City, Utah*

By H. D. RANDALL†

IT is the intent of this paper to list, in a quantitative way, the power capacity of developed plants, and to estimate the additional water-power available for future development within the territory tributary to Salt Lake City. While the physical limit to long-distance electric transmission cannot yet be definitely set, pending further scientific knowledge of corona, line disturbances, and other similar phenomena, it is highly improbable that the

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future will bring forth any new methods or materials which will greatly change the cost of those items affecting the transmission of power. For local conditions, the limiting radius may be chosen purely as a commercial problem, and while it is not subject to exact solution, it is probable that 150 miles is not far from the maximum distance that power can be profitably transmitted for rates at which it is now being sold in the Salt Lake district. Even within this 150-mile radius, markets will develop in the vicinity of certain plants to absorb power at higher rates than the Salt Lake rate, less the cost of transmission, so that not all the power within even this radius is strictly 'tributary' to this market.

The developed water-power plants, excluding some few municipal systems of insignificant capacities, as far as known to me, are listed herewith, the capacities given being the normal manufacturer's rating in kilowatts.

Plants marked with an asterisk are private or municipal, serving a local market, hence should be excluded from this paper. However, as it is intended to consider the general local power market, and not strictly that of the city of Salt Lake, no differentiation is made between power used here or in Ogden, Provo, Bingham, or other districts. This leaves a rated capacity of 66,850 kw.; but as the majority of these plants suffer from a shortage of water for a greater or less portion of each year, the continuous capacity is materially less than the above total. Since this reduction factor varies with the stream flow, from month to month and from year to year, and since two water-power plants in the same system but on different water-sheds may overcome one another's deficiencies, or an auxiliary steam plant may supply the deficiency due to low water, I do not care to assume the responsibility of stating a reduction factor that would

Stream.	Plant.	Head, ft.	Kw.	Kw.
Ogden river	Pioneer plant of Utah Light & Railway Co...	485	6,000	....
Weber river	Oakley plant of Knight Power Co.....	390	3,500	....
" "	Devil's Gate Plant of Utah Light & Railway Co.	180	2,500	....
" "	Davis & Weber Counties Canal Co. power plant.	204	3,250	....
Provo river	Murdoch plant of Knight Power Co.....	196	2,500	....
" "	*Municipal plant, city of Heber.....	90	....	600
" "	Olmstead plant of Telluride Power Co.....	339	7,200	....
Logan river	*Municipal plant, city of Logan.....	...	....	500
" "	Logan plant of Telluride Power Co.....	214	2,000	....
" "	*Plant of Agricultural College of Utah.....	30	....	400
Bear river	Grace plant of Telluride Power Co.....	484	11,000	....
" "	Wheelon plant of Utah-Idaho Sugar Co.....	121	7,800	....
Battle creek	Battle Creek plant of Telluride Power Co....	1,750	2,400	....
Blacksmith fork of Bear river	Browning & Eccles power plant.....	260	2,500	....
Jordan river	Narrows plant of Telluride Power Co.....	75	1,000	....
Box Elder creek	*Municipal plant of Brigham City.....	300	....	750
Mill creek	Knight Power Co.:			
" "	Mill Creek No. 2.....	1,050	1,400	....
" "	Mill Creek No. 1.....	350	350	....
Big Cottonwood creek.	Stairs station of Utah Light & Railway Co...	360	1,800	....
" " "	Granite station of Utah Light & Railway Co.	450	1,750	....
American forks	Alpine plant of Knight Power Co.....	1,900	1,750	....
" "	Utah Fork No. 2 of Knight Power Co.....	600	1,200	....
" "	Utah Fork No. 1 of Knight Power Co.....	300	600	....
Snake creek	Knight Power Co., Snake creek.....	700	1,200	....
Santaquin creek	Knight Power Co., Santaquin creek.....	650	1,000	....
Willard creek	*Willard plant of Browning & Eccles.....	1,200	....	350
Baker creek	*Ogden Portland Cement Co.....	1,200	....	175
High creek	*High Creek Light & Power Co.....	...	....	550
Farmington creek	Davis County Light & Power Co.....	490	....	300
Little Cottonwood	*Columbus Con. Mining Co.....	185	....	600
Spanish fork	*United States Reclamation Service.....	125	....	1,000
South Willow creek	*Clark Electric Co.....	1,050	....	400
Ophir creek	*Clark Electric Co.....	...	....	300
Tooele creek	*Clark Electric Co.....	...	....	250
Snake river	American Falls	45	3,750	....
Manti creek	*Gunnison Valley Pr. Co.....	280	....	350
Total			66,850	6,225

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be acceptable to the plant operators. It is believed, however, that allowing for this deficiency factor and for average transmission losses, that there is available or will be available when certain plants included in the above list and now under construction are complete and in operation, approximately 45,000 kw. for delivery at tributary markets. While it is not within the province of this paper to estimate the present demands of the power market or its rate of increase, it is certain that this does not provide any considerable margin and that future requirements necessitate rapid further development.

In a country as comparatively unsettled as this is, and with meagre water records and survey data, it is hardly possible to list exactly all of the potential power-sites or to estimate closely their power capacities or economical development. Capacities based on average stream flow or even on the usual minimum flow are so much in excess of the power available with extreme minimum flow, that the streams not yet developed are generally discussed on the basis of storing flood waters to regulate minimum stream flow.

As a general rule, storage of flood waters for the purpose of power generation is not commercially feasible. For very high heads, where a small improvement in regulated flow increases materially the continuous output of the plant, it may not be prohibitive in cost, but as high heads can be collected only in the upper water-sheds, the topography generally prevents large reservoirs.

In some cases, storage of flood waters, primarily for irrigation, may guarantee stream regulation for power plants situated between such reservoirs and the point of diversion of irrigation ditches, and this condition obtains today on the Upper Snake river. Further irrigation projects under consideration in that section promise still better stream regulation; but this is an unusual condition and one that may hardly be expected to occur in Utah. The unregulated minimum stream flow, or regulated only by diurnal reservoir, must be regarded as the normal flow and the measure of value of the stream for power development purposes, at least with power rates now maintaining and power markets now available. It is on this basis that the following streams have been investigated.

By using Bear lake as a reservoir, the flow of the Bear river can be equalized for a flow of 1250 cu. ft. per second at Grace and Oneida narrows and 1400 cu. ft. per second in Bear River canyon at Wheelon. This flow can be utilized under 450-ft. effective head at Grace, 180-ft. head at Oneida narrows, and 115-ft. head at Wheelon, giving 63,800 kw., or an increase of 45,000 kw. over the generator ratings now installed on this stream.

The Green river has a rapid drop from its origin in Wyoming to Jensen, Utah, below which the drop is 5 ft. per mile without notable falls. A number of small plants can be developed, but there are no opportunities for very large plants nor natural reservoir sites for stream regulation. Above Jensen, Utah, 10,000 kw. can be developed. Between Jensen and Green river, Utah, 17,500 kw. can be developed, based on 1000 cu. ft. per second flow and utilizing 280 ft. of the 696 ft. existing drop. Of the remaining 416 ft. fall, a portion may be utilized in very low head plants, but the above estimate of 27,500 kw. is believed to cover liberally all power which can be commercially developed at present.

The Snake river at American falls, owing to stream regulation for irrigation rights below, now has a consistent

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minimum flow of 5000 cu. ft. per second with an effective head of 48 ft., so that 11,250 kw. additional can be developed at that point. The Duchesne has present power possibilities of 5000 kw., but irrigation requirements may be expected to reduce this total materially. Ashley creek also offers possibilities of development up to 5000 kilowatts.

The Weber river, while already developed with 9250 kw., offers additional power facilities, due to the fact that irrigation requirements will almost certainly regulate stream flow. This is estimated at 5000 kw.; but may be greater, depending upon the degree of storage and stream development. Blacksmith's fork of the Bear river can be developed for an additional 2000 kw., Rock creek for 1250 kw., East fork of the Bear 1000 kw., Pontneuf river 1000 kw., and Box Elder creek 750 kw. The upper tributaries of the San Rafael can develop about 1000 kilowatts.

The Green below the town of Green river, Utah, the Grand and Colorado, also the Sevier are beyond the range of economical transmission. Strawberry river, Rock creek, Willow creek in Uintah county and the White will be stored or diverted for irrigation and consequently offer no considerable power possibilities. The Uintah, the Price, and a number of other smaller streams have sufficient fall and flow to develop a few hundred horse-power, enough to furnish utilities to towns in the vicinity; but not of interest in the present discussion.

The following list summarizes the additional development mentioned above.

Stream.	Additional power in kw.
Bear river	45,000
Blacksmith's fork of Bear river	2,000
East fork of Bear river	1,000
Green river	27,500
Snake river	11,250
Duchesne	5,000
Ashley creek	5,000
Weber river	5,000
Rock creek	1,000
San Rafael	1,000
Pontneuf	1,000
Box Elder creek	750
Total	105,750

Allowing for transmission losses this will give about 90,000 kw. of available delivered power as against the 45,000 kw. now in operation or under construction, but it must be remembered that outside of the Bear river and the American falls site of the Snake river, that these are unproved plants and that thorough investigation might show many of these sites incapable of commercial development under present conditions.

Inductive Interference Between Power and Communication Lines

EARLY in the official life of the present Railroad Commission of the state of California, many cases of inductive interference between the power lines and the lines of communication systems were brought up for official settlement. It was found that comparatively little is known accurately as to the quantitative effect of different factors on the disturbances in communication circuits, although a great deal of theory of induction phenomena has been worked out. It was felt that if the question could be discussed at length, some valuable results might be obtained which would assist the com-

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mission in determining under what conditions parallels between high-tension power-lines and communication-lines are permissible, and in issuing regulations governing thereafter the construction and operation of such lines in proximity to each other, so that the inductive interferences common to such parallelism could be minimized. Accordingly, the Railroad Commission early in December 1912 invited companies owning and operating electric-power lines and telephone and telegraph lines in the state of California to meet informally and discuss the question of appointing committees representative of the many interests concerned, to form an organized investigating board, which, together with representatives of the commission, should constitute a joint committee empowered by the Railroad Commission to conduct tests and experiments, the results of which should serve as a basis for future regulations of the commission.

The conference met December 16, 1912. Four representatives were selected by the power interests, four by the communication interests, one by the railroad interests, and four were appointed by the commission. At a subsequent meeting, the joint committee was increased by the selection of one more representative of the power interests and one of the communication interests, making a total of fifteen. The committee organized under the name of The Joint Committee on Inductive Interference by the election of a chairman, a secretary, and a treasurer, and by the appointment of sub-committees on ways and means, finance, transportation, program, and publicity, as permanent committees, and by the appointment of a committee to supervise and to analyze the results of tests.

Assistance from the power, telegraph, and telephone companies in the shape of money contributions and from the railway companies in the shape of transportation for men and apparatus was requested. All of the companies interested in the work were requested to assist by furnishing such men and apparatus as might be available for the work, and by permitting the committee to use the communication and power lines for tests to be made at such times that they would not interfere with the public service. All parties concerned in the investigation have joined in the most liberal manner to meet these requests.

Already some work had been done by the Pacific Telephone & Telegraph Co. and the Coast Counties Gas & Electric Co. in an investigation of a parallel in Santa Clara valley. A sub-committee was appointed to complete the work on this parallel, and their jurisdiction was extended over the second proposed series of tests at Salinas.

Since one of the reports of the test committee outlines essentially the method used in making both the first and the second series of tests, the following extracts are quoted from it:

Method of Making Tests

In the following paragraphs are outlined the tests which are to be made on the communication circuits and power circuits for each condition of the power line.

A. Tests on Telephone Circuits.—The tests on telephone circuits are designed to give quantitative information regarding the total effect of the power lines on the telephone circuits and also regarding the effect of each harmonic in the power system on the telephone circuits.

The tests which are outlined here are those which past experience indicates will most efficiently and completely give the information required.

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Preliminary Work.—During the tests all of the circuits on the telephone-pole lead will be disconnected from the rest of the telephone system at each end of the exposure, in order to obtain definite testing conditions and to avoid the effects of secondary induction from other parallels in the system. As this procedure completely interrupts service over the telephone lead, it will ordinarily be necessary to make the tests at night. Good grounds will be made at the test poles at each end of the exposed section of the telephone line. Two pairs of wires, well insulated and well transposed, will be run from the station where the tests are to be made to the telephone pole line.

Condition Tests.—Two telephone lines will ordinarily be connected-in for test at the same time, and, where possible, these two circuits will be side circuits of a phantom so that these tests may be made at once on two physical circuits and one phantom circuit. The tests will be made on a sufficiently large number of telephone circuits to ensure that an idea has been obtained of the extreme and average conditions of the lead. The tests are briefly outlined below.

1. Tests of the capacity and insulation balance of each telephone circuit.
2. Tests of the total noise induced in the telephone circuits.
3. Tests of the current flowing between telephone wires and ground on short circuit and of the voltage induced between telephone lines and ground on open circuit.
4. Observations of the voltage from each power line to ground and also of the residual voltage, that is, the vector sum of these three voltages. Observations also of the current in each line wire and of the residual current, that is, the vector sum of these three currents.
5. Resonance analyses of the induction between telephone wires and from telephone wires to ground, and of the above named voltages and currents in the power system.
6. Oscillograms of the voltages and currents in the power and telephone systems mentioned in item 5.

B. Tests on Telegraph Circuits.—Arrangements will be made by which all of the telegraph circuits on the telegraph line may be opened at the same time for short periods, during which tests are being made in order to obtain definite testing conditions, and to eliminate the effect of secondary induction. Arrangements will also be made so that the telegraph wires may be looped one at a time into the stations where the tests are being made.

Tests will then be made on each telegraph wire of the voltage to ground with both ends open-circuited and with the distance-end connected to ground, and of the current flowing through the circuit with both ends connected to ground. A sufficient number of oscillograms should be taken to determine the wave shapes of the induced disturbance under different conditions.

These tests will be carried out on a sufficiently large number of telegraph wires to determine to what extent the disturbance is different for circuits on different pin-positions of the telegraph lead.

Simultaneously with the above tests, observations will be made of the voltage and currents in the power line as outlined in paragraphs 4, 5, and 6, under 'Tests on Telephone Circuits.' These observations need, however, include only the magnitudes of the fundamental and of the one or two most prominent harmonies.

C. Tests on Railroad Signaling Circuits.—Observations and oscillograms will be made of the maximum alternat-

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ing current induced in the railroad signaling circuits under different conditions.

D. Miscellaneous Tests.—It may be found desirable to make further tests on some other types of equipment, such as the telegraphone or of the other types of circuit which are not considered above.

Conditions of the Power Circuit.—The following is a general outline of the different conditions of the power circuits under which tests should be made. In this outline, no attempt has been made to go into detail, as it is felt that the detailed tests will be modified according to the exigencies of operation and that additional tests will be suggested by the results of the tests here outlined:

1. Tests with the power-line cut dead, to determine that under these conditions, the signaling circuits are free from disturbances.
2. Tests of the inductive disturbance under normal operating conditions, both light and heavy load.
3. Tests of the effect of different transformer connections on the induction in signaling circuits.
4. Tests of the effect of grounding and opening the neutrals of star-connected transformers.
5. Tests of the effect of operation of relief and emergency steam stations.
6. Tests of the effect of charging aluminum lightning arresters.
7. Tests of the effect of switching high-tension lines.
8. Tests of the disturbance caused by known residual voltages and currents. In these tests the conductors of the power line involved in a given parallel will be cut dead and a known voltage will be impressed between the three power wires in parallel and the ground. Tests of the effect of unbalanced current will be made by passing a known current through each of the line wires with a ground return.
9. Tests with one line wire grounded. In these tests the method of procedure will probably be to create a ground on one wire when the line is dead and then to switch potential on the circuit.

The sub-committee on program is analyzing information now being sent in by the communication and railroad companies concerning parallels with which they are now experiencing difficulty, and information which the power companies are sending in regarding their systems. With this information it will report recommendations for future tests. It is hoped that within a year or two valuable results will be obtained which may serve as the basis of recommendations to the Railroad Commission. It is the intention of the joint committee through the sub-commitee on publicity to furnish to the technical press from time to time such information as may indicate to the engineering public and to the corporations concerned, the nature of the work being undertaken and the results obtained up to the date of publication of the report, in so far as these results can be considered to be final.

The object of making such a publication is for the information of the interested companies and of the engineers of the country, with the expectation that they will show an interest in the work now being done in California by such constructive criticisms and suggestions as will further the work of the Joint Committee on Inductive Interference, and that in the end all sections of the country may profit by the results of their labors.

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Gravity of Crude Oils

Arranged by WM. H. KRITZER

THE instruments used in the United States for measuring the gravity of oils are a thermometer graduated in Fahrenheit degree and a Baumé hydrometer. The hydrometer consists of a stem or tube of uniform diameter marked with graduations from 10 to 100, a bulb containing air, and a small bulb at the bottom containing shot or mercury, which causes the instrument to float in the liquid in a vertical position. The hydrometer, when placed in a receptacle containing oil, sinks to the point on the scale which indicates the gravity in degrees Baumé. The temperature for which the Baumé scale is graduated is 60°F., or 15.5°C., and for any variation in temperature, correction must be made. The graduations on the Baumé hydrometer are figures of an arbitrary scale, the instrument being made in two forms, one for measuring the density of liquids lighter than water, and one for those heavier than water. With the former type, the reading 10 corresponds to the specific gravity of pure water, which is 1, but the scale on the Baumé hydrometer for liquids heavier than water is so graduated that the zero reading corresponds to the specific gravity of pure water. Specific gravity may be defined as the weight of a unit volume of any substance compared with that of a like volume of pure water at a temperature of 60°F. A gallon of water weighs 8.333111 lb., and under these conditions has a gravity of 10° on the Baumé scale. Accordingly, if the hydrometer indicates that the gravity of a certain oil distillate is 28.5°B. and the temperature of the oil at this reading is 70°F., the temperature then is 10°F. above the temperature base of the Baumé scale, and the corrected reading is 28.5° − 0.5° = 28° Baumé.

Formula for converting Baumé readings for liquids lighter than water to specific gravity:

$$\text{Specific gravity} = \frac{140}{130 + \text{degrees Baumé}}$$

Thus: where gravity Baumé = 18° at 60°F., specific gravity $= \frac{140}{130 + 18} = 0.9459$.

If the weight in pounds of a gallon of oil at a temperature of 60°F. is known, its Baumé gravity may be calculated by the following formulas:

Let W = weight in pounds of 1 gal. of oil at 60°F.

Sp Gr = specific gravity.

B = degrees Baumé.

Then (1) $\text{Sp Gr} = \frac{W \times 12}{100}$ (2) $B = \frac{140}{\text{Sp Gr}} - 130$

Example: Take a gallon of crude oil that weighs 7.62 lb. By (1) we find the specific gravity to be 0.915. Taking formula (2), we find the Baumé gravity to be $\frac{140}{0.915} - 130 = 23°$.

Purchasers of oil products have heretofore relied on color, distillation of samples, fire test, and gravity as shown by the Baumé hydrometer.

To correct the differences in Baumé gravity due to temperature changes, the arbitrary rule has been introduced and accepted by the trade in general,

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B°	Sp. Gr.	Weight per Gallon	Weight per Barrel	Weight per Cu. Ft	B°	Sp. Gr.	Weight per Gallon	Weight per Barrel	Weight per Cu. Ft.
10	1.0000	8.328	349.79	62.301	45	.8000	6.663	279.83	49.841
11	.9929	8.269	347.31	61.859	46	.7955	6.623	278.26	49.560
12	.9859	8.211	344.86	61.422	47	.7910	6.588	276.68	49.280
13	.9790	8.153	342.45	60.993	48	.7865	6.550	275.11	48.999
14	9722	8.097	340.07	60.569	49	.7821	6.514	273.57	48.726
15	.9655	8.041	337.72	60.152	50	.7778	6.478	272.07	48.458
16	.9589	7.986	335.42	59.740	51	.7735	6.442	270.56	48.189
17	.9524	7.932	333.14	59.335	52	.7692	6.406	269.06	47.922
18	.9459	7.878	330.87	58.931	53	.7650	6.371	267.59	47.660
19	.9396	7.825	328.67	58.538	54	.7609	6.337	266.16	47.405
20	.9333	7.773	326.46	58.145	55	.7568	6.303	264.72	47.149
21	9272	7.722	324.33	57.765	56	.7527	6.269	263.29	46.894
22	.9211	7.671	322.19	57.385	57	.7487	6.235	261.89	46.644
23	.9150	7.620	320.06	57.005	58	.7447	6.202	260.49	46.395
24	.9091	7.571	317.99	56.637	59	.7407	6.169	259.09	46.146
25	.9032	7.522	315.93	56.270	60	.7368	6.136	257.73	45.903
26	.8974	7.474	313.90	55.909	61	.7330	6.105	256.40	45.667
27	.8917	7.426	311.91	55.554	62	.7292	6.073	255.07	45.429
28	.8861	7.379	309.95	55.205	63	.7254	6.041	253.74	45.193
29	.8805	7.333	307.99	54.856	64	.7216	6.009	252.41	44.956
30	.8750	7.287	306.07	54.513	65	.7179	5.979	251.12	44.726
31	.8696	7.242	304.18	54.177	66	.7143	5.949	249.86	44.502
32	.8642	7.197	302.29	53.840	67	.7107	5.919	248.59	44.277
33	.8589	7.153	300.44	53.510	68	.7071	5.889	247.34	44.053
34	.8537	7.110	298.62	53.186	69	.7035	5.859	246.08	43.829
35	.8485	7.066	296.80	52.862	70	.7000	5.829	244.85	43.611
36	.8434	7.024	295.02	52.545	71	.6965	5.801	243.63	43.393
37	.8383	6.982	293.23	52.227	72	.6931	5.772	242.44	43.181
38	.8333	6.940	291.48	51.915	73	.6897	5.744	241.25	42.969
39	.8284	6.899	289.77	51.610	74	.6863	5.716	240.06	42.757
40	.8235	6.858	288.05	51.305	75	.6829	5.687	238.87	42.545
41	.8187	6.818	286.38	51.006	76	.6796	5.660	237.72	42.339
42	.8140	6.779	284.73	50.713	77	.6763	5.632	236.36	42.134
43	.8092	6.739	283.05	50.414	78	.6731	5.606	235.45	41.935
44	.8046	6.701	281.44	50.127	79	.6699	5.579	234.33	41.735

to either add or subtract 1° hydrometer reading for every 10° of temperature below 60°F.; so for every 10°F. below this point, add 1° to the Baumé reading, and for every 10° above 60°F., subtract 1° from the Baumé reading.

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This rule may not affect materially a small transaction, but it makes a material difference when sales of large quantites of oil are made.* If it were possible to standardize the oils required by different branches of industry, and ascertain exactly what the standard should be for each purpose for which it was to be used, it would then be more satisfactory to buy oil on specifications and know that you would obtain an oil that fulfilled the requirements, instead of having to purchase some 'special' brand.

System in Engineering Contracting

SYSTEMATIC handling of labor and material is what counts in contracting. Macdonald & Kahn were contractors for the construction of a 5-story reinforced-concrete store for Hale Bros. at the corner of Fifth and Market streets, San Francisco. The ground to be occupied covered a frontage of half a city block on both Market and Fifth streets. This space was covered with two-story frame buildings which had to be torn down and removed before building could be started. The contract price was $250,000 in round numbers. A guarantee was made that the building would be completed and ready for occupancy within six months after the date of the contract, with a bonus and penalty clause of $1000 for each day under or over the time limit called for.

The first step was the preparation of the progress schedule shown in the illustration. The arrangement and method employed will well repay careful study. As every successive step in building construction is dependent upon the one preceding, it will be obvious from a study of the schedule that the contractors knew at every stage of the work whether or not progress was being made to conform to their guaranteed date of completion. Copies of the schedule were posted in various places on the work, so that foremen and workmen of each craft knew what they were expected to accomplish. The progress photographs shown give an excellent indication of the several stages in the course of construction. Advantage was of course taken of the exceptional facilities offered in San Francisco for the rapid and economical construction of work of this nature. The greater part of all material used was produced within easy distance of San Francisco. Cheap power in the form of oil from the California fields and electricity generated in the California mountains was available for use. All material was hauled to the site in motor trucks. Structural steel aggregating 1100 tons was used, at a total cost, in place, of $175,000. The use of the Kahn system

*Note.—Authorities differ as to the amount of this correction. J. H. Thompson and Sir Boverton Redwood, in the 'Handbook on Petroleum,' say that the correction depends to some extent upon the character of the product. In the case of kerosene, it is usual, for commercial purposes, to add to, or deduct from, the observed specific gravity 0.004 for every 10°F. above or below 60°F. This corresponds to about 0.5° on the Baumé scale. The coefficient of expansion of mineral oils is higher and of lubricating oils lower than that of kerosene, so that for these products the addition or subtraction should be, respectively, somewhat greater and somewhat smaller, 0.005 and 0.003 being nearer to the actual figure. Augustus H. Gill, in his 'Oil Anaylsis' (6th Edition), says that for every increase of 10°F. (5.50 C.), subtract 1°B. from the hydrometer reading.—EDITOR.

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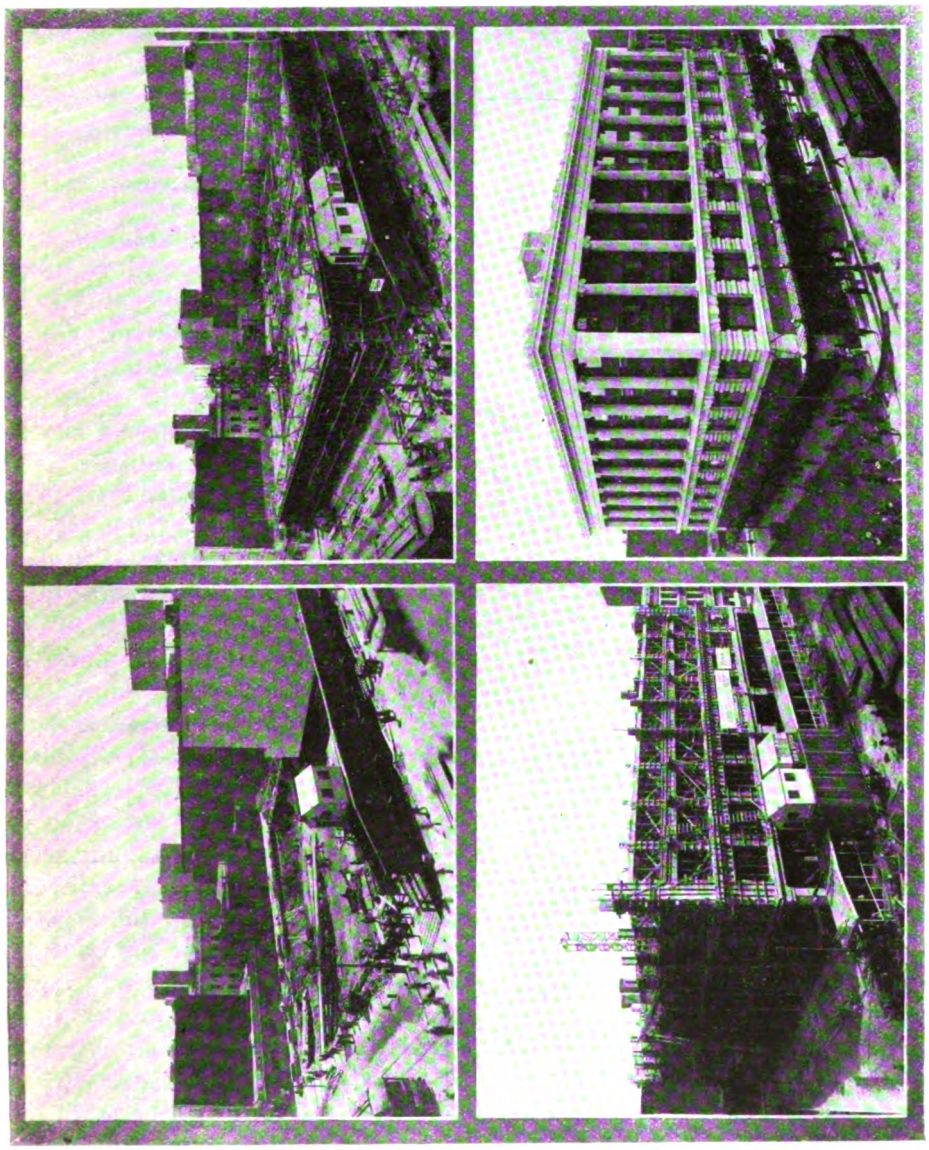
of reinforced concrete permitted the entire frontage of display windows to be kept clear without supporting pillars. The total concrete placed was 12,000 cu. yd. with an additional 2000 cu. yd. of sleeper fill. The floor space, including basement, aggregated 230,000 square feet.

The first view shows the condition of the site on April 11, 1912, after the removal of the frame structures. The second view was taken 45 working days later and shows the second floor poured. A motor truck is dumping sand upon the street-level plank-screens, from which it sifts to basement storage. Condition of the work 22 working days after the second view, is shown in the third picture of the series. The fourth floor forms are practically set. The



PROGRESS VIEWS. CONSTRUCTION OF HALE BUILDING, SAN FRANCISCO.
FIG. 1. FIG. 2.
FIG. 3. FIG. 4.

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DATE	EXCAV. AND CONCRETE	STRIPPING	PLASTERING	SHEET METAL	WOOD WORK	ORNAMENTAL IRON	ELEVATORS	SPRINKLERS HEATING	ELECTRIC WORK
APRIL 5	EXCAV. STARTED								
16	START FOOTINGS								
25	EXC FIN								
MAY 4	ALL FOOTIN					STRUCT STEEL			
5						COLUMNS			
9								SET SLEEVES	18TH FL
11	1ST ARCHES								
18	FIRST POURED								
19				SET WINDOWS	SET FRONT				
23	MEZZ FORMS			IN REAR	FRAMES				
26	MEZZ POURED							FIRST PIPES	
JUNE 4	NINTH FLOOR FORMS								
11	NINTH FLOOR POURED								
13		BSMT							
18	TENTH FLOOR FORMS							SECOND PIPES	
20		BASE FLOOR POURED		SET WINDOWS	SET				
27	TENTH FLOOR POURED			IN REAR	FRONT FRAMES				
29		FIRST STRIPPED					START ELEVATORS		
30		MEZZ					UPPER FLOORS		
JULY 2		FIRST FLOOR POURED	START FIRST						
4	FOURTH FLOOR FORMS								
6								TENTH PIPES	
11	FOURTH POURED								
13		SECOND STRIPPED							
16		SECOND SLEEPERS	FIRST FINISH		FLOORS AND FINISH	FIRST STAIRWAY			
18			SECOND START	COVER DOORS				FOURTH PIPES	FULL FIRST
20	FIFTH FLOOR FORMS	SECOND FILL		FIRST FLOOR	SASH WINDOW	SASH WINDOW		FIRST HEADS	
21				STRUCT STEEL	HARD DOORS				
23				PIPE BRACKETS					
25					SET FLOORS 18TH FLOOR				
28	FIFTH FLOOR POURED								
30		THIRD STRIPPED		ART MARQUISE	FIRST FINISH			FIFTH PIPES	
AUG 3		THIRD SLEEPERS			START SECOND				
4	ROOF FORMS	THIRD FILL	SECOND FINISH	ART SKYLIGHT				ART MARQUISE	
6			THIRD START					ROOF	PULL SECOND
8								SECOND HEADS	
10	ROOF POURED	FOURTH STRIPPED							
13		FOURTH SLEEPERS	FOURTH START						
15	PENT HOUSE FORMS	FOURTH FILL			SECOND FINISH		ALL CARPET IN		
17					START THIRD				
18			THIRD FINISH						
20								THIRD HEADS	
24	PENT HOUSE POURED	FIFTH STRIPPED	START EXTERIOR	PLACE CORNICE					
25			FIFTH START				SECOND ELEVATOR		
27		FIFTH SLEEPERS			THIRD FINISH		TURNING		
29		FIFTH FILL			START FOURTH				
31			FOURTH FINISH					FOURTH HEADS	
SEPT 3			FIFTH FINISH		START FIFTH				
5								FIFTH HEADS	
7					FOURTH FINISH				
8		PENT HOUSE							
10			EXTERIOR FINISH				ALL ELEVATORS		
12							TURNING		
14					FIFTH FINISH				

fourth view shows the finished building, taken 85 working days after the third progress picture. The result of the careful arrangement of a systematic schedule of performance and its satisfactory execution was shown by the completion of the contract 15 days in advance of schedule time and a bonus of $15,000 earned by the contractors. After all, a first-class executive plus system are the keynotes to financial success in contracting.

American manufacturers will be interested in a law passed November 5, 1912, by the Republic of Panama authorizing the importation, free of duty, of machinery for the development of agriculture and certain other industries. The provisions of the law are as follows: "In addition to the articles free of duty under the existing laws and contracts, the following articles shall be admitted free of duty: Plows, rakes, sickles, stump-pullers, machines for cutting, sawing, and planing lumber, seeders and planters; machinery for use in sugar refining and machinery for the harvesting of coffee, cacao, rubber, and tobacco; machinery for preserving fruits for exportation and machinery for the extraction and preparation of pigments and rosins; locomotives, rolling stock, rails, and machinery in general for the construction and maintenance of railroads, and crushers to be used exclusively for the construction and repair of roads; machinery for excavating and extracting mineral oils, and shoe machinery; machines and accessories for preparing and preserving hams and other meat; machinery for textile manufacturing, for the digging of artesian wells, and for the construction and maintenance of canals for navigation and irrigation."

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The Engineering Digest

Arnold Transportation Report *

OWING to the extensive nature of the Arnold investigation and the large amount of material already submitted, the Board of Supervisors has extended an invitation to Mr. Arnold to sum up the results of his investigation thus far, prior to the final recommendations. In the absence of Mr. Arnold, the board was addressed by J. R. Bibbins, his resident engineer, who has been in active charge of the work.

Since the organization of the Arnold transit-bureau last year, there have been submitted from time to time to the Board of Supervisors 16 reports, dealing with special subjects preliminary to the final report now in press. In general, these covered tunnels, cars, service, extensions, exposition transit facilities, relief of lower Market street, present and future growth, and charter amendments.

The serious deficiencies in street plan and the difficulties of reaching outlying districts were shown to be largely responsible for settlement restricted to nearly one-half of the city, which settled area practically conformed to the 30-minute time zone figured from the business centre, Third and Market streets. And although a handicap of 15 to 20 minutes against transbay commuters existed, yet the highly developed electric train service to Alameda county has resulted in the inclusion of Oakland, Berkeley, and Alameda in the 5-cent commuter zone, whereas it is impossible to reach even the county line of San Francisco in some cases for the same fare. On the other hand, it was shown by Mr. Bibbins that through the medium of the Twin Peaks tunnel and other rapid-transit outlets, the 30-minute time zone would be in effect extended to the beach on the west and below the county line on the south for local traffic, and possibly as far as San Mateo for high-speed trains; so that the needs of this city lie largely in the direction of extension of rapid-transit facilities rather than lack of patronage.

A careful analysis of growth showed that traction lines are at least 6 years behind in extensions, and that a construction program should be started immediately, involving some 70 miles of single track. These extensions have been carefully planned by a study of every grade in the city, its relation to position of population and possible transit lines; and a program is mapped out calling for about 15 miles of track per year up to 1920, till the system has caught up with itself, and from 40 to 50 additional cars per year. This program is considered by Mr. Arnold as the minimum necessary for San Francisco to keep pace with its growth. It is found that the average person of this city contributes perhaps twice as much for transportation as other cities of its class, even exceeding Los Angeles in this respect, and that this contribution ($20 per capita) exceeds that in the form of taxes for defraying the entire running expenses of the municipal government.

Mr. Bibbins showed the very encouraging fact that although San Francisco lost heavily in population as a result of the fire, the subsequent growth has been more rapid than before, and that the city has more than regained its lost ground; and further, that the exodus to transbay cities has ceased, so that San Francisco and its surrounding communities from now on will continue rapid growth as a metropolitan district, which for the best interests of the entire community should be united under a metropolitan district control of such matters of common in-

*Reviewed by his resident engineer, J. R. Bibbins, in preparation for submission of final complete report.

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terest as transportation, water, and police.

With a present population of nearly half a million for the city, and over three-quarters of a million for the entire commuter district, including San Francisco, the predictions made by Mr. Arnold after an accurate analysis of growth indicate that a city of one million inhabitants will have to be provided for within about 30 or possibly 25 years; and about double this population for the total metropolitan district within the same period. This prediction was made, to obtain an adequate conception of the necessary investment in transportation facilities which would have to be made either by private or municipal capital, and this investment increases at least three times as fast as the earnings.

As in other cities, it is found that in San Francisco, earnings from transportation quadruple as the population doubles, but that the purchasing power of the city as based upon its present bond limit does not nearly keep pace with the necessary investment. Mr. Arnold found this disparity so great that if the city were absolutely free from debt it would require continually about one-third of the city's entire bonding power for investment in transit facilities alone, which fact unmistakably points to the necessity of encouraging the investment of private capital unless the city can enlarge its bond limit to cover this necessary investment. Mr. Bibbins emphasized the possibilities of the district assessment plan of extensions by citing the fact that the abnormal rise in property values in northern Manhattan island due to the building of the subway was enough to pay for the entire cost of the bore.

The necessity of adequate transportation facilities to the exposition and the inadequacy of only one or two lines, as contemplated, were again emphasized by Mr. Bibbins, and in the course of the discussion, the Arnold estimates previously made were fully confirmed by Mr. Mortensen, traffic manager of the exposition, after further study of the situation. If a line is to be built on Van Ness avenue, it was recommended that the rapid transit parking plan proposed by Mr. Arnold should be used, which would provide uninterrupted service during the most congested periods, leaving a 30-ft. roadway on each side, one of which could be reserved for parades and the other for vehicles. Mr. Bibbins laid great emphasis upon the necessity for preserving in all important thoroughfares, a freeway for vehicles to pass between cars and other vehicles standing along the curb, and to this end urged the reduction of sidewalk widths and the adoption of the Chicago standard of cars and track centres as exemplified in the new municipal railway equipment.

In defending the reasonableness of the Arnold estimates for exposition transportation, he showed that the estimated maximum demand of 50,000 persons per hour exceeded the total outbound travel of the entire city from the business district during the evening rush hour, and that the maximum line capacity of 12,000 persons per hour exceeded the present traffic on Market street during the same period.

In discussing the types of cars, Mr. Bibbins pointed out emphatically that the new Geary street cars conformed to the high standard which the city itself imposed upon private transportation companies, combining comfort with reasonable capacity, quick loading, and increased power and safety. He pointed out that while the city of Portland limits by ordinance the amount of standing to not over 20% of the seating capacity, the Geary street car can comfortably accommodate double the seating capacity and a maximum of 100 to 110 passengers without interfering with passenger movement; and that the speed of loading is far superior to any cars at present in operation here. By employing a more compact construction, the Chicago standard of car width and track centres could save 18 in. from the roadway, with practically the same aisle space as now available in the McAllister street cars.

In the Arnold recommendations for the improvement of the present United Railroads equipment, it was stated that this loading speed could probably be improved 25% by the suggested modifications in platform arrangement, such as the removal of the bulkheads, straightening of guide railing, and the conversion of the 1300-class cars now operating on Fillmore street into prepayment equipment; also the lengthening of the Powell street cars and abolishing the turntable at Market street was recommended.

An investigation of traffic conditions lasting several months showed that much of the congestion is due to slow loading, both along Market street and at the Ferry, and entirely inadequate terminal facilities there; this congestion resulting in uneven headway and erratic loading of cars, although the equip-

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ment was generally found to be so well maintained that practically all cars were available for rush-hour service. The shortage in cars resulted in such gross overloading on the Market and especially the Mission street lines that as many as 90 passengers were missed by the conductor on a single trip. As a result of these traffic counts, Mr. Arnold found that the 65 new cars on order would hardly have sufficed for proper service as of last July, disregarding the increasing traffic at the rate of about 5% per annum.

In his final report on re-routing, detailed assignment of increased service will be made. He has concluded that in view of the four-track plan of operation, the inner tracks have about reached their capacity, and that while present routes thereon may be retained, future additional traffic must be diverted to the streets of the Mission, and that on account of the inadequate terminal facilities at the Ferry, other loop and stub terminals must be provided elsewhere.

For relieving lower Market street, Mr. Arnold recommended a plan of tandem stops, with two cars crossing intersecting streets together, which has already produced results. Also loading at both ends of the cars, abolition of unnecessary stops, and rearrangement of safety stations so that the present seats at the ends will not obstruct access to the car platforms. The work of the police traffic squad in regulating traffic at crossings is highly commended as a means of facilitating transit.

As to the ultimate outcome of transit necessities in San Francisco, Mr. Bibbins laid great emphasis upon the fact that unless the city is ready to acquire the present railway properties and build extensions thereto according to the demand, there is no other way except by the adoption of the Chicago re-settlement plan of indeterminate franchise as exemplified in charter amendment 34. This represents a great improvement upon the original Chicago plan in that both intangible and tangible values would be automatically retired by the company; that adequate service would be continuously secured; extensions would be built as required; property would be continuously maintained to the highest standard; and that the city could buy over the property when ready to do so at a far less price than it could organize a new company; or if the city's share in earnings were allowed to accumulate, the entire property would be ultimately recaptured free of cost.

As an illustration of what this plan has done for Chicago, Mr. Bibbins showed comparative results from other cities in the distribution of gross income between company and the public, wherein Chicago receives a larger percentage than any other city and at the same time has laid up a total of about $12,000,000 in 5 years which can be applied to the building of subways. In the final report this re-settlement plan will be worked out in actual money values as applied to San Francisco, and shown to be practical for meeting the present conditions as proved by an exhaustive analysis of the financial and operating records of the United Railroads for the past 10 years; and the essential requirements of a general franchise ordinance covering both new and re-settlement franchises will be presented in line with the provisions of charter amendment 34 as an enabling act. The city will have specific recommendations as to means of remedying present defects, the exact amount of improvements and extensions of service for both present and future, the legislative machinery necessary to carry out these improvements, and the final results of the recommended plan of settlement projected for the future so far as the term of the franchise grant contemplated.

The Proposed National Highway

SHALL the United States build highways is a question which is slowly but surely forcing itself upon the national legislature. Many senators and representatives now believe that the building of a system of national highways is of more economic importance than any other public work—more vital than the question of a large navy, more useful than any river and harbor improvement, more necessary than the Panama canal. A few years ago road bills had short shrift in Congress—at present there are nearly a hundred bills before Congress dealing with road building in one form or another.

Although the 'good roads' idea has been gathering force and headway for many years,

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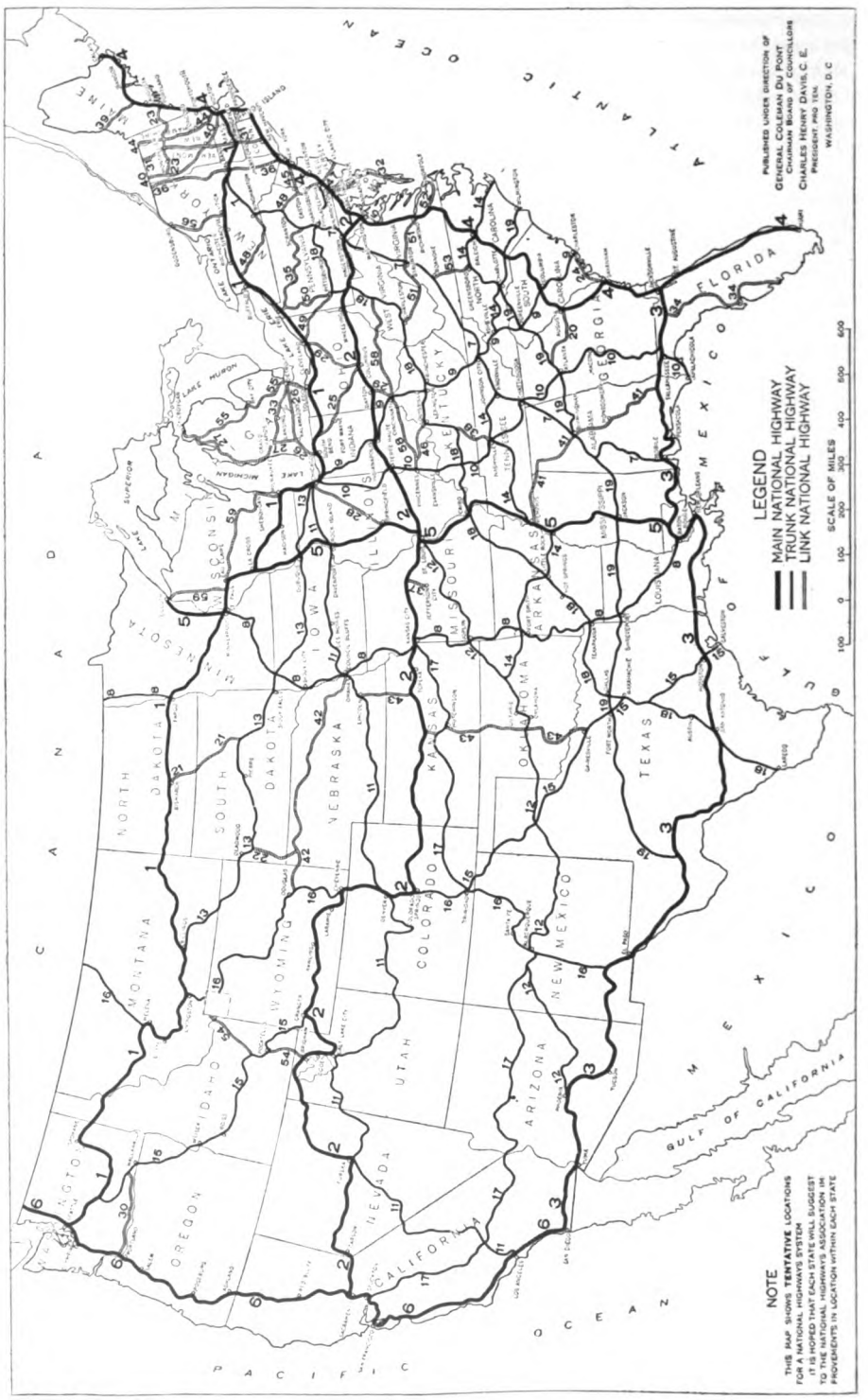

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its advocates are still pulling in many directions. Some road associations want state highways with national aid. Others want state highways without national aid. Still others want good roads paid for by the counties through which they pass, without any aid. One, at least, believes firmly that the question is not only one for states, counties, cities, and towns, but for the nation.

The National Highways Association believes that the beginning of a comprehensive good-road system for the nation must be made by the Federal government.

Such a system—as outlined on the map published here—consists of 50,000 miles of national highways. It is not intended that this map should represent the entire good-road system needed by the United States. It is merely a tentative suggestion of the national system of national highways, from which good roads built by states, by counties, and by cities and towns, would grow and multiply.

It is universal experience that one mile of good road brings about the construction of another mile. Put a state-wide, good road down anywhere in this country, and in ten years there will be dozens of good roads reaching it from all parts of the state. Put down a system of national highways, built and maintained by the national government, and the various state legislatures and county officials would soon see the advantages of connecting all parts of the states with those national roads.

There are 2,000,000 miles of roads in the United States. The 50,000 miles of highway shown on the map is but a fraction over 2% of this mileage. But improve these 50,000 miles into good roads, and keep them good roads by proper maintenance, and 50,000 miles more would grow almost over night, and then another 50,000, and another and another, until our great country, with its huge territory, would be crossed and re-crossed with good roads, as France is today.

France has national highways. These are immense trunk-line roads, great arteries of commerce, and from these the smaller roads are built by the provinces of France, just as the states and counties of our states will build feeders and connections to a national system of highways.

If France—about the size of Texas—needs national highways, how much more are they required in the United States with its enormous and sparsely settled territory?

Many idealists and dreamers have proposed national road systems for this country. Usually the system has been worked out with a map, a ruler, a pencil, and sublime faith. Mountains, lakes, rivers, and forests form no obstacles to such visionary road systems. The national highways system, as shown on this map, is the product of no such dream. The highways indicated are either the best present roads from point to point, or what are, in the judgment of a trained and experienced corps of road engineers, the best possible and practicable roads from one point to another.

But these engineers, who worked months on hundreds of large scale maps, and with the aid of a nation-wide correspondence of more than 15,000 personal letters asking information and advice, know this system is only tentative. It is but a suggestion. It is not intended to be anything else. There must be a beginning to everything, and little headway can be made without some such careful plan from which to start.

Study the map and see where your home lies with relation to the highways. If it is on a main, trunk, or link line, you will probably like the system. But if you live somewhere that this system does not touch, don't condemn the system. Remember that it is designed to connect the states with each other. It is intended to touch every large city, every state capital, and to bring closer together the several parts of the country. The roads are as straight as the contour of the country will permit, without an impossible expenditure of money to tunnel mountains or bridge lakes and rivers. Remember, too, that your locality would be connected with such a system by a local road in a very short time.

Notice that there are three classes of highways, main, trunk, and link. The main highways are six in number, Northern, Central, Southern, Atlantic, Mississippi, and Pacific. These form the starting point and the basis of the system. Next come thirteen great trunk lines, feeding and crossing the main highways, and connecting the various sections of the country in more intimate relations. Finally come 40 link highways—smaller national highways—making a grid-iron of the whole system.

To build such a system complete will take a man's lifetime and a huge amount of money. If the wealth of the world were

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ready to build this system tomorrow, it would still take many years, because there are availabie neither engineers nor knowledge enough to do it quickly.

When this, or a similar system of national highways is built—and built it surely will be some day—it will be by a national highways commission, which first locates and then builds one or more roads at a time, learning as it builds. When this huge amount of money is spent—as spent it is bound to be—it will be gradually and through an annual appropriation.

If New York state can afford $5,000,000 per year for road building, is it unreasonable to suppose the United States government can afford ten times as much—or $50,000,000 per year?

Think it over. Look at the map. Study it and see how it will affect you and your home. If you have any suggestions to make, or criticisms to offer, the National Highways Association would like to hear them.

The system as outlined is only a beginning—a suggestion. But if it appears as a beautiful dream, it is at least a practicable, engineers's dream, and a dream which—like that of de Lesseps and the canal—is bound to come true some time. The National Highways Association believes that the time when the dream begins to come true is close at hand. It is a dream which vitally effects every man, woman, and child in the country—a dream which, when it does come true in its entirety, will be found of more importance to our progress as a nation, to our wealth, to our social and political life, and to our other dream of absolute independence, than any other movement we, as a nation, have ever made.

Federal Leasing of Oil Lands

PROPOSALS for the leasing instead of sale of the oil lands remaining in possession of the United States Government have been made repeatedly in the past five years, and there is a growing conviction among those who oppose, as well as those who approve, that some such system will ultimately be placed in operation. Few concrete plans have been submitted, and the Mining and Metallurgical Society of America has taken the lead in attempting to formulate the principles upon which a leasing system should be based. The report below covers the tentative suggestions now before the society. It is based upon a report from a special committee of the San Francisco Section, modified after discussion by the New York members. It is understood that M. L. Requa, chairman of the sub-committee that prepared the original report, dissents strongly from section 4, preferring distribution by lot rather than competitive bidding. Discussion of the whole matter by readers of *Western Engineering* will be welcomed by the Editor.

1. There being no laws at present under which oil land can be acquired satisfactorily, a special Federal law should be enacted, governing the acquirement of oil, gas, and asphalt lands, and all lands known or reasonably supposed to contain oil, gas, or asphalt should be disposed of only under the terms of the new law.

2. From time to time as the desirability of maintaining a stable price for oil may, in the opinion of the Secretary of the Interior, demand, oil, gas, and asphalt lands now reserved or hereafter withdrawn, shall be thrown open in entry blocks of such size as he shall determine. In fixing the size and position of the blocks, he shall recognize the principle that the pioneer may properly be allowed a larger area than the one who follows.

3. Prior to the opening of any lands to entry, they shall be properly surveyed and suitably monumented, and they shall be divided into tracts of 160 acres.

4. Where two or more individuals or corporations desire to lease the same tract of land the lease shall be allotted by the Secretary upon the basis of competitive bids, the proffers to be in terms of royalty offered, and all royalties to be chargeable and payable in terms of the product. Whenever a lease is thus allotted to a bidder in competition with others it shall consist of such an acreage as shall be fixed in each particular case by the Secretary; but no lease allotted without competitive bidding shall contain more than 320 acres. No allotment shall be made of any lease or leases unless in the opinion of the Secretary the individual or corporation acquiring the lease shall be financially able to develop the property completely and to care for it during and after development in

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the manner best calculated to bring about its greatest production and least waste, with due respect to neighboring properties.

5. Successful entrymen shall file with the Secretary a good and sufficient bond to the amount of $10,000 for the faithful performance of the terms of the contract. The Secretary, in making these leases, is empowered, in cases where he thinks it advisable, to substitute for the aforesaid bond of $10,000, either a bond in a less amount or an annual rental for the acreage reserved.

6. Lessees shall commence drilling within a specified and agreed time, and all money expended upon the lease in a bona fide effort to develop oil, gas, or asphalt, or to operate for oil, gas, or asphalt, shall apply to the extinguishment of the bond, and when the total amount so expended equals the amount of bond the latter shall be canceled.

7. Transfer of leases shall be valid only upon approval of the Secretary and he may refuse approval whenever in his judgment such transfer would be contrary to public interest; but he shall not use his power of refusal as a means to exact increased royalty.

8. The lessee shall drill each year an agreed number of wells or shall keep in operation an agreed number of strings of tools unless the local price of oil falls below a certain agreed price. If the lessee forfeits a lease, he shall retain his rights in all wells already drilled and may continue to produce from them so long as he pays the agreed royalty, and forfeited leases shall be immediately open to reletting; provided no drilling shall be done within 300 ft. of an existing well.

9. Line wells must be drilled last except where it is necessary to protect a lease against adverse drilling.

10. Net revenue from leasing the oil lands should go in large part to the state within which the lands are situated.

High-Vacuum Condenser Tests*

DATA given below are from tests on a condenser of the dry-tube-base design, manufactured by the Wheeler Condenser & Engineering Co., Carteret, New Jersey, installed at the South Works of the Illinois Steel Co., South Chicago, Illinois, in connection with a 7000-kw. Curtis mixed-pressure turbo-generator.

Low-pressure steam is supplied by three 2000-kw. compound reciprocating engines, which discharge into a header about 100 ft. long. In addition to this supply of steam,

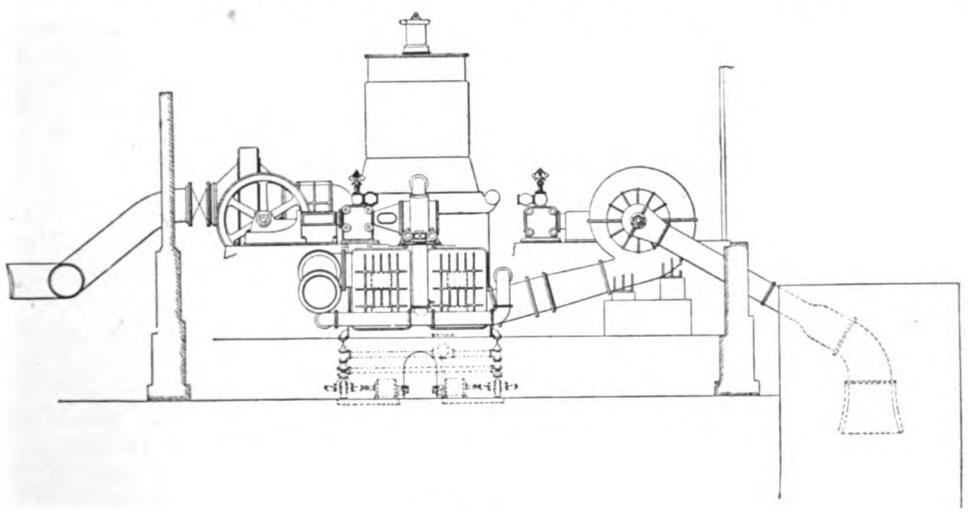

FIG. 1.

*From information furnished by the Wheeler Condenser & Engineering Co., Carteret, New Jersey.

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the exhaust from blast-furnace blowing engines and auxiliaries is used up to a capacity of 200,000 to 250,000 lb. per hour. High-pressure steam is used to carry the load in case of a deficiency in the supply of exhaust. The arrangement of condenser and auxiliaries is shown in the drawings of Fig. 1 and 2. The condenser-tube surface is arranged in two sets of banks on either side of the centre line, with dry plates at several elevations on each side draining outward toward the shell. They divide the tube surface into a number of compartments, designed to give the most efficient and even distribution of the steam to all of the surface.

There are about 6000 1-in. tubes, making in all about 25,000 sq. ft. of surface. The tandem rotative dry-vacuum pump and has shown remarkable efficiency, as indicated by the tests of table 2. Two 5-in. centrifugal hot-well pumps are installed, driven by 24-hp. steam turbines.

The following vacuums were guaranteed with temperature of cooling water 70°F., and the quantity of water, not more than 34,000 gal. per minute.

Vacuum.	Load in lb. of steam per hr.
28.3	210,000
28.5	185,000
28.6	150,000
28.7	120,000
28.9	70,000

A summary of the tests made by the steam

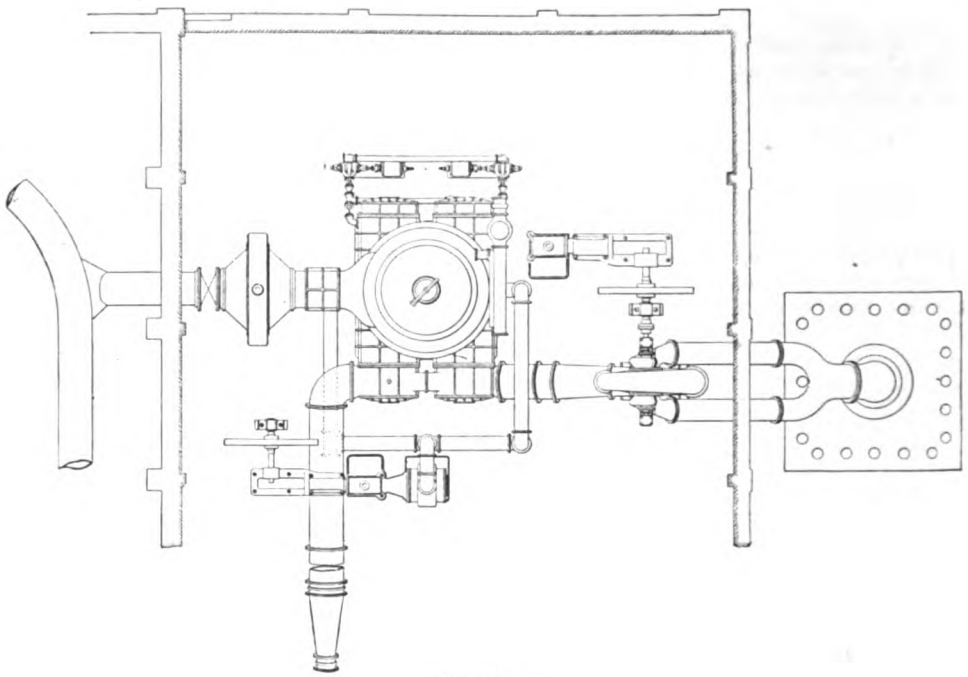

FIG. 2.

circulating water makes two passes through the tubes, entering at one end and passing through the lower bank of tubes on both sides of the centre, returning through the top bank to the discharge. The circulating water is drawn from Lake Michigan through an intake tunnel 150 ft. long, and discharged to a sewer. The circulating pump is a Wheeler 36-in. double-suction volute pump, operating at a speed of 100 to 135 r.p.m. driven by a 20 by 24 Cooper-Corliss engine. The dry-air pump is a 14 by 36 by 24 Wheeler

engineering department of the Illinois Steel Co. to check the guaranteed values is given by table 1. The tests were made in July with inlet circulating water at 73.4 to 73.7°F. In calculating the final results, the performance was corrected to 70° water and a smooth curve, drawn between vacuum and load, is given in the chart of Fig. 3. The same chart also gives the actual vacuums with the water averaging about 73.6° Fahrenheit.

Referring to table 1, the following items should be noted:

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TABLE No. 1

TEST OF WHEELER DRY-TUBE SURFACE CONDENSER, ILLINOIS STEEL CO., JULY 1910

Average vacuum referred to 30-in. barometer	Temperature corresponding to vacuum	Pounds steam per hour	Hot-well temperature	Temp. inlet circulating water	Temp. outlet circulating water	Rise in temperature of circulating water	Coeff. of heat trans. B.t.u. per hr. per sq. ft. per deg. diff. (based on 980 B.t.u. per lb. of condensate)
28.246	96.9	196,000	90.6	73.40	86.1	12.7	470
28.250	96.8	187,000	90.5	73.40	85.5	12.1	440
28.310	95.7	167,000	89.4	73.40	84.4	11.0	403
28.394	94.05	169,000	88.7	73.40	84.6	11.2	462
28.374	94.50	171,000	88.8	73.40	85.2	11.8	466
28.331	95.30	190,000	89.4	73.40	85.8	12.4	500
28.304	95.80	197,000	89.8	73.40	86.2	12.8	509
28.290	96.08	204,000	90.1	73.40	86.6	13.2	528
28.286	96.15	210,000	90.3	73.40	86.9	13.5	550
28.311	95.70	190,000	89.3	73.40	85.5	12.1	480
28.380	94.32	187,000	89.2	73.40	85.4	12.0	519
28.361	94.75	190,000	89.4	73.40	85.8	12.4	522
28.443	93.05	175,000	89.1	73.40	84.2	10.8	504
28.473	92.50	171,000	87.7	73.50	84.6	11.1	532
28.501	91.85	167,000	86.2	73.70	84.1	10.4	535
28.510	91.70	163,000	87.5	73.70	84.0	10.3	526
28.551	90.75	157,000	87.8	73.70	83.0	9.3	521
28.590	89.80	148,000	86.2	73.70	82.8	9.1	525
28.595	89.70	130,000	87.7	73.60	81.5	7.9	435
28.678	87.80	121,000	85.2	73.60	81.5	7.9	487
28.748	86.05	93,000	84.8	73.50	79.5	6.0	395
28.748	86.05	98,000	83.7	73.50	80.5	7.0	447
28.786	84.90	98,000	83.7	73.60	80.1	6.5	500
28.803	84.70	91,000	83.3	73.60	80.0	6.4	478

TABLE No. 2

TEST OF WHEELER R. D. V. PUMP, ILLINOIS STEEL CO., JULY 1910

Time.	Speed.	Steam cylinder. M. E. P.	Steam cylinder. I. hp.	Air cylinder. M. E. P.	Air cylinder. I. hp.	Mech. Eff.
3:21	81	32.80	61.9	5.40	53.7	86.8
3:26	93	35.00	75.6	5.55	63.3	83.5
3:30	93	34.15	74.0	5.25	60.0	81.1
3:35	94	32.50	71.1	5.37	62.0	87.1
3:40	93	34.00	73.6	5.43	62.0	84.2
3:45	94	33.70	73.8	5.36	61.8	83.7
3:50	94	33.50	73.3	5.48	63.2	86.2
3:55	93	34.25	74.2	5.46	62.4	84.0
4:00	93	34.50	74.7	5.33	60.9	81.5
4:05	94	33.25	72.8	5.55	64.0	88.0
4:10	93	34.00	73.8	5.36	61.2	83.0
4:15	94	35.00	76.6	5.36	61.8	80.7

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Time.	Speed.	Steam cylinder. M. E. P.	Steam cylinder. I. hp.	Air cylinder. M. E. P.	Air cylinder. I. hp.	Mech. Eff.
4:20	94	34.50	75.5	5.43	62.6	83.0
4:25	93	34.00	73.6	5.36	61.2	83.2
4:30	94	34.10	74.6	5.31	61.2	82.0
4:35	93	33.35	72.2	5.25	60.0	83.1
4:40	93	33.35	72.2	5.37	61.3	84.9
4:45	93	34.40	74.3	5.33	60.8	81.7
4:50	94	34.35	73.0	5.40	62.3	85.3
4:55	93½	32.50	70.6	5.36	61.5	86.9
5:00	94	33.45	73.2	5.28	60.9	83.2
5:05	94	34.10	74.6	5.22	60.2	80.7
5:10	94	32.70	71.6	5.19	59.8	83.5
Average	93	33.76	73.1	5.37	61.2	83.89

The remarkably high vacuums obtained with cooling-water at 73.5° temperature.

The small difference in temperature between the discharged condensing water and the steam, that is, 4 to 10 degrees.

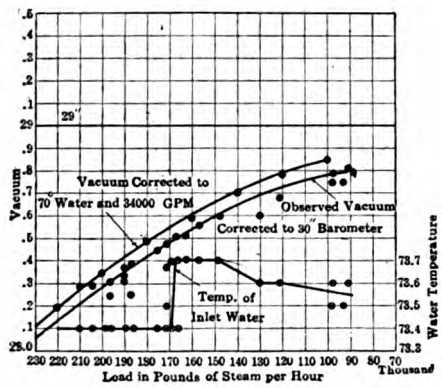

FIG. 3.

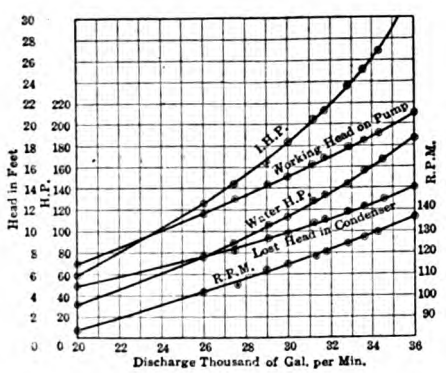

FIG. 4.

The high hot-well temperature, ranging only 2 to 6° below steam temperature.

The high coefficient of heat transmission, 550 B.t.u. per sq. ft. per hour per degree difference in temperature with a load of 210,000 lb. of steam per hour.

The greatest load on the condenser was 210,000 lb. of steam per hour, but it is evident from the test that a load of 250,000 lb. of steam per hour would have carried with 28-in. vacuum and 70° water. This is equivalent to 10 lb. of steam per square foot of surface, and under these conditions, the coefficient of heat-transmission would have been about 600.

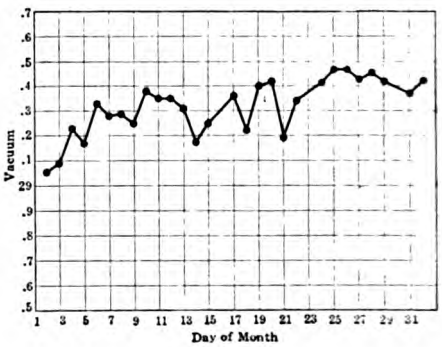

FIG. 5.

The coefficients of heat-transmission are calculated on the basis of 980 B.t.u. per pound of condensate, and by the logarithmic formula for heat transmission.

The test on the Wheeler dry-vacuum pump is covered by table 2. The mechanical efficiency of 83.9% obtained, is remarkably high. The test on the centrifugal circulating pump is covered by the chart of Fig. 4.

A log of a month's performance of this condensing outfit is shown graphically by the chart of Fig. 5. This log covers performance in the month of January with inlet cooling water down to about 34°F. The performance is markedly consistent.

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Keokuk Hydro-Electric Development*

A CONSTRUCTION project which involves, in its execution, laying 650,000 cu. yd. of concrete and the consumption of over 7000 tons of structural steel, and which has for its purpose the development of over 300,000 hp. by damming the Mississippi river and installing 30 hydro-electric units of unprecedented size, must be of interest to business men, engineers, capitalists, and others concerned in the industrial development of the country. Such a plant is now being built at Keokuk, Iowa, by the Mississippi River Power Company.

The entire development comprises the following three important features: A spillway, bridge-type dam extending 4694 ft. from the east (Illinois) side of the river; a powerhouse, 1718 ft. long, parallel with the river and extending downstream from the end of the dam on the Iowa side; and a short dam with navigation lock connecting the lower end of the powerhouse with the Iowa shore. The short dam forms the forebay for the powerhouse and also includes a drydock adjacent to the lock.

The main dam consists of a series of 119 arched spans, with piers 6 ft. thick and spans of 30 ft. inside. The spillway sections are, therefore, each 30 ft. long and 22 ft. high. The structure is 29 ft. wide on top, sufficient for a double-track standard-gauge railway, and 42 ft. at the bottom. The powerhouse is a concrete monolith, and is designed to contain 30 vertical special Francis type turbo-generator units of 10,000 normal horse-power. Only 15 units are being installed at the present time; the remainder will be added as the demand for power increases. Eight of the turbines are furnished by the I. P. Morris Co., Philadelphia, and seven by the Wellman-Seaver-Morgan Co., Cleveland. The generators, which are designed for a normal output of 7500 kw. each, at 11,000 volts, 3-phase, were all built by the General Electric Company.

The navigation lock is 400 ft. long and 110 ft. wide with a 40-ft. lift, and the drydock is 115 by 463 ft.; both are fitted with massive steel gates to be operated by compressed air. The power for the operation of the lock and drydock machinery will be generated by a special installation of turbines. The lock, drydock, and appurtenances are being built by the Mississippi River Power Co. at its own expense, and will be deeded over to the United States upon completion. The new lock will pass a steamer in from 10 to 15 minutes, and will reduce the time required to navigate the Des Moines rapids by over 2 hours.

In addition to the features mentioned, the power company is constructing a concrete ice fender, 2325 ft. long, to protect the forebay in winter, and is building a seawall 1110 ft. in length and from 45 to 73 ft. high to protect the tracks of the Chicago, Burlington & Quincy railroad, along the Iowa shore, from high water. The dam will create a quiet lake with a minimum depth of 8 ft., extending 60 miles up the river above Keokuk. Twenty-five miles of macadam highway is being constructed around the lower end of the lake by the power company. Since the plant is being built in a navigable stream, all the plans must be approved by the chief of engineers of the War Department. One reason for the unusual massiveness of everything connected with the dam and power-plant is found in the low head available, which necessitates the employment of large units to obtain the requisite power. The normal head is only 32 ft., but will range from 20 to 39 ft., depending on the stage of the river.

All of the work is handled by direct administration, none of it having been let to contractors. About 2500 men are employed. Before anything could be done, a large construction plant had to be assembled; this involved an initial outlay of about $1,000,000. To gain some idea of the immensity of this one feature of the project, it may be said that the construction plant includes 15 miles of standard-gauge railroad track with 60-lb. rails, 16 locomotives, 142 cars, 10 derrick cars, 3 steam-shovels, 10-ton stationary derricks, 9 concrete mixers with a daily capacity of 3500 yd., stone-crushers of equal capacity, 50 miles of iron pipe, 44 steam boilers of 3755 aggregate horse-power, centrifugal pumps with a capacity of 32,660 gal. per minute, air-compressor capable of handling 6761 cu. ft. of free air per minute, 10,000,000 ft. of lumber, and 1250 tons of structural

*Abstract from *The Iron Trade Review*, F eb. 27, 1913.

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steel for concrete forms. In all, over 6000 different articles were bought, ranging in variety from a few bolts of odd size to 11 automobiles, before a stroke of work was accomplished on the construction of the plant proper.

When the plant is completed and delivering power to consumers it will represent a total cost of approximately $22,000,000, on which the fixed charges, including depreciation, interest, and taxes, will be close to $2,860,000 per year.

Not the least important feature to be considered in a project of this character is the financial economy, choosing in every instance the thing that will result in an ultimate saving, without regard to the number of dollars saved at the particular moment. This accounts for the expenditure of $1,000,000 on the construction plant—on tools, in a large sense—before proceeding with the real work at hand. This same problem is constantly recurring. In one instance it had to do with the substructure of the powerhouse in connection with the second installation of 15 units. The question was whether to build the whole powerhouse up to its floor, above the new water-line, while the coffer-dam and facilities are in place, or to do it later when needed, in a new coffer-dam. Calculation showed that the interest on the cost of the substructure was more than the cost of building another coffer-dam. Hence only a solid wide wall, which later will be the west side of the lower part of the powerhouse, is being built now to connect the upper half of the powerhouse with the lock.

To attain the highest efficiency possible, considerable attention was devoted to the organization of the work. The topography and size of the area covered made it practicable to divide the construction work into two entirely separate divisions, each under the immediate charge of a superintendent. One of these is called the Illinois division, its plant being situated on the east side of the river; the other is known as the Iowa division, and is entirely on the west side of the Mississippi. The Illinois division is building the dam proper, extending from the Illinois bluff across the river to join the powerhouse. The Iowa division is building the powerhouse substructure, the turbine installation, the lock, the drydock, the seawall, and the entire hydraulic part of the development on the west side of the river. All of the parts of the various structures named are designed and planned by the company's engineering department under the direction of the chief engineer. The electrical work, and its correlated parts, is being executed by the Stone & Webster Engineering Corporation, of Boston.

The Keokuk plant is the result, largely, of the personal efforts of Hugh L. Cooper, an eminent hydraulic engineer; but before he came on the scene the matter had been agitated in public and in private for two generations. Through his efforts and with the coöperation of the Stone & Webster syndicate, the capital necessary for the present work being executed by the Mississippi River Power Co. was obtained. It was subscribed for in comparatively small lots, 35% in the United States and 65% in foreign countries—Canada, England, France, Germany, and Belgium, chiefly. The dam is being built on the authority of the original franchise obtained by the Keokuk & Hamilton Water Power Co., which has been taken over by the Mississippi River Power Co. The money advanced by the cities of Keokuk and Hamilton has been returned to their respective municipal treasuries.

Nearly all of the previous water-power development in the United States has been on the edge of the country, from California along the Canadian border and down the Atlantic coast to the Carolinas, thence across Georgia and Tennessee to Alabama. The Keokuk plant is the only very large development in the heart of the nation. In size it exceeds the development in any one state except three—New York, Maine, and California—by the latest census reports, and is about half the total of all five companies at Niagara.

A total of over 300,000 hp. will be developed, 310,408 to be exact, but the first installation of 15 turbines will have a normal capacity of only 150,000 hp. Allowing for transmission losses and reserve, it is expected that there will be 120,000 hp. available for sale before the close of the summer. Of this quantity, 60,000 hp. has been sold on a 99-year contract to the Union Electric Co. of St. Louis, which will retail it through the usual channels.

The new plant is adjacent to the cheapest steam-coal fields in the country, and it will therefore be necessary to sell the power at low figures. At the present price of coal, the cost of power produced in isolated steam

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plants varies from $24 to $50 per hp-year, the lower figure being for modern plants with comparatively large units operating condensing. It can be definitely stated, although the actual rates have not yet been fixed, that the electrical power will be sold at prices ranging from $20 to $25 per hp-year.

At present the Mississippi River Power Co. is developing the territory within its reach in a lineal instead of in a radial direction; that is, only two transmission lines are being built, one up-river to Burlington, and the other down-stream to St. Louis. The reason for this is obvious from considerations of economy, since the two transmission lines now building reach the largest number of power consumers at minimum expense, and the cost of covering the entire circle at the outset by radial lines would be prohibitive. Also, the power company intends to do a wholesale business only, leaving the retail distribution to consumers to separate or subsidiary concerns. Therefore, the parent company will consider propositions from other companies that may wish to build transmission lines to the west or east, tapping the main lines between Burlington and St. Louis or the central plant at Keokuk.

The total length of the main transmission lines is 180 miles, it being 137 miles from Keokuk to St. Louis and 43 miles from the same point to Burlington. The Burlington line is aluminum, and the St. Louis line is copper. Both lines are constructed on private right-of-way, 100 ft. wide; they are built in duplicate, and the usual precautions have been taken to avoid interruptions to the service by lightning or other causes. The transmission voltage is 110,000, with one exception the highest in the country. This figure was adopted to reduce the line drop to a minimum, and to increase the economical radius of transmission. The energy loss between Keokuk and St. Louis will be 9%. Twenty-five cycle 3-phase current is to be furnished, and while this frequency is ideal for most power purposes, it is often unsatisfactory for lighting, and it is probable that frequency changers will be found desirable at several points.

The principal cities which will be served by the new plant include Keokuk, Montrose, Fort Madison, and Burlington, Iowa; Warsaw, Hamilton, and Quincy, Illinois; and Hannibal, Louisiana, Old Monroe, and St. Louis, Missouri. Current also will be delivered to the various suburban towns surrounding St. Louis on both sides of the river. Within this region the total manufacturing development at the present time is well advanced. The problem of the power company is therefore not that of opening up a new country, but rather to convert large users of coal to the purchase of electricity.

In order to be ready for the operating stage of the enterprise, the Mississippi River Power Co. is already perfecting its permanent organization. Edwin S. Webster, of Boston, is president, and Hugh L. Cooper vice-president and chief engineer. In immediate charge of the operating department is J. A. Trawick, manager, assisted by R. W. Child. The industrial department is in charge of J. A. McKinney; N. P. Wilcox is sales manager, and C. H. Harris, resident engineer.

To the engineer interested in the development of hydro-electric power from the Des Moines rapids of the Mississippi river, the geological surveys and hydraulic data which cover the physical fundamentals of the problem are of primary concern. The channel of the river, which skirts southeastern Iowa, is of comparatively recent origin and was originally situated some distance to the west. The old channel, however, was dammed at some prehistoric time by the intrusion of a glacier and the river forced to the east. The conditions which caused the river to cut a valley 5 to 10 miles wide in the preglacial age were absent in the post-glacial age, when the present channel constituting the Des Moines rapids was cut through. As a result, the bluffs at the rapids are closer to the present river than at any other point south of St. Paul. This allows a dam at Keokuk with a comparatively small area overflowed by the pool above, thus keeping the cost of flood damages within reasonable limits and making the project one that is financially feasible. The Des Moines rapids extend for a distance of about 12 miles from Keokuk to Montrose, Iowa; between these points the river bed has a fall of 23 ft. The surface fall is about 23 ft. at low water and 16 ft. at high water, the greater part of this fall being in the lower 8 miles. The river is in a solid limestone formation and its bed is practically smooth, so that there is no broken water or surface disturbance during ordinary stages. The river is nearly a mile wide and has a depth of about

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seven feet at mean low water.

Observations extending over a period of 20 years indicate that the volume of water flowing through the river at this point varies from 20,000 cu. ft. per second at low water to 372,500 sec-ft. at flood stage. The mean water-level will be raised about 35 ft. by the dam, and the normal working head on the hydraulic machinery will be 32 ft., although this will vary from 20 to 39 ft. from high to low water.

The dam forms a pool 60 miles long above Keokuk, and will flood about 3000 acres of land, about 65% of which is on the Iowa side and 35% on the Illinois side. Practically all of this land was purchased from the owners by private negotiation, over 800 different persons being involved. In only about half a dozen cases has it been necessary to institute condemnation proceedings. The main dam is a concrete structure, extending 4278 ft. from its east abutment, the latter being 290 ft. long. The structure is peculiar in that it is being built first as a viaduct and then converted into a dam. At first a series of 119 arched spans, 30 ft. long, resting on piers 6 ft. thick, were constructed, forming a bridge from the Illinois shore to the northeast corner of the powerhouse. Later the openings between the bridge piers were filled by concrete weirs, so that in the total length of 4278 ft. of dam there is 3570 ft. of spillway. Unwatering the bed of the river was accomplished by a coffer-dam which was kept continually ahead of the construction work on the main dam. The coffer-dams were built of timber cribs, loaded with stone, faced with plank, and sealed water-tight with clay. Special precautions and soundings were taken to fit the cribs tightly to the river bottom.

The water-level in the lake may be raised above the crest of the spillway by steel gates which close each 30-ft. opening up to the springing line of the arches. The gates are steel panels, 11 ft. high and 32 ft. long over all, and they slide in grooves in the piers. Each gate consists of a framework of 18-in. I-beams, covered with ⅜-in. steel plate on the up-stream face. They will be opened and closed by a traveler or derrick car running along the bridge which forms the top of the dam; to determine the pull which this derrick would be required to exert, one of the gates was set up under actual conditions and allowed to rust fast in its groove for seven weeks. Nitric acid was used to accelerate and increase the corrosion. At the end of the period, the gate was moved by a hydraulic jack, which permitted a measurement of the force required.

One of the special features in the construction of the dam was the use of steel instead of wood forms for molding the concrete. These forms were designed by B. H. Parsons, mechanical engineer. They are built of structural steel shapes and are faced on the inner side with steel plates. The forms are made in panels 5 ft. wide, so they may be readily moved by means of block and tackle. Each panel is slightly shorter than the one below, to provide for the batter of the end of the piers. In the upper panels diagonal members are used so that the structural framing forms a truss. This is done in order that when the lower panels are removed the upper ones will be sufficiently strong to carry the load of green concrete in the arches. For the arches between the piers, three steel-hinged trusses, made in two sections with a transverse joint at the crown, were used to carry the curved plate which formed the lagging. All the forms were left in place about a week, with 5 days as a minimum, to allow the concrete time to set. A complete set of pier and arch forms could be erected in about 6 hours.

A steel traveler or crane, running along the top of the finished portion of the structure, was used in palcing concrete ahead of the completed piers. Its weight, 175 tons, was carried by six wheels running on two rails forming a wide track. To operate the machine and the concrete-handling tackle, twa 10-hp. and three 40-hp. steam hoisting engiuer were employed.

Expansion joints in the dam are provided at each pier by casting a sheet of heavy tar-paper on edge in the concrete. The paper lies in the middle line of each pier and extends from the floor of the viaduct down to a level with the bottom of the arches. The paper is elastic and acts as a cushion against which the concrete may expand; when the paper rots out, there will remain an open slot. Elaborate concrete mixing plants have been established on both sides of the river. A cross-section through the axis of one of the turbo-generating units is illustrated in Fig. 1. The powerhouse substructure is practically a solid mass of concrete, 1700 ft. long and 123 ft. wide, with its floor 45 ft. above the river bed. In this monolith are formed the wheel pits, scroll

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chambers, draft tubes, etc., carrying the water to and from the wheels. The power-house superstructure is reinforced concrete. It will be 125 ft. wide and is divided longitudinally by a wall forming a series of arched recesses in which the transformers will be placed. The generator-room will be three passages and the common one, into which they merge, are all rectangular in cross-section, the floor and roof being level throughout. Water enters the three passages at a velocity of 5 ft. per second for normal head, and is uniformly accelerated to 7 ft. per second opposite the axis of the wheel.

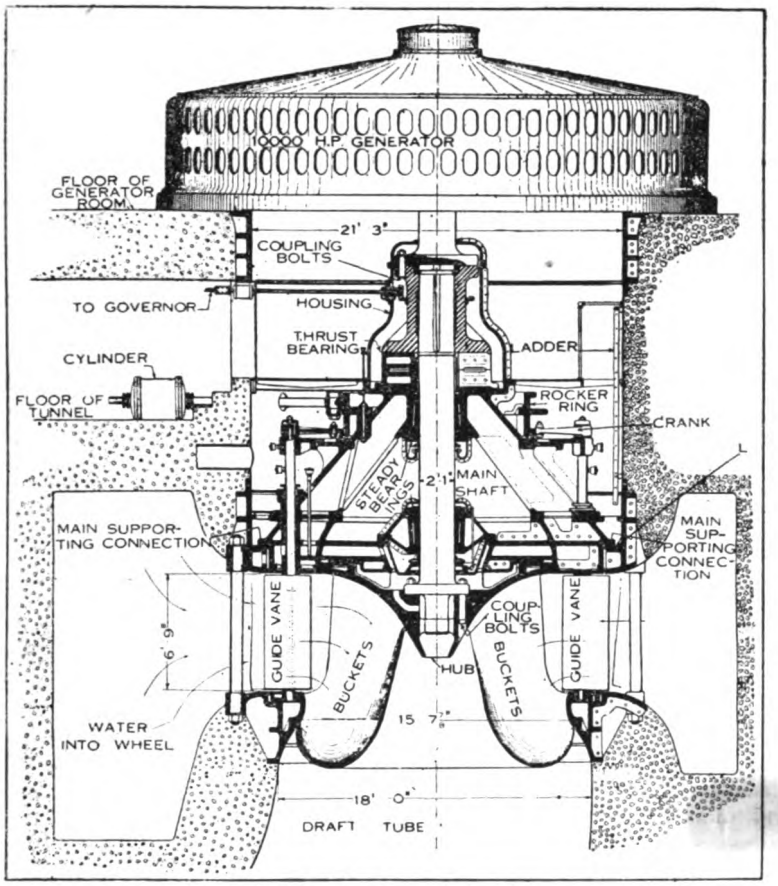

FIG. 1. SECTION ELEVATION OF ONE OF THE TURBINE UNITS.

on the river side of the building. The entire building will have an upper story, or gallery, in which will be placed the oil switches and other electrical auxiliaries.

For the present, fifteen 7500-kw. vertical generating units and two exciters will be installed. The water from the forebay goes to each turbine through four intake openings, each of which is protected by a screen and guarded by a gate. Three of the intakes merge by easy curves into a common passage, which is tangent to the distributer at a point opposite the axis of the wheel. The From this point the design follows that of an ordinary scroll case, and the successive areas around the distributer are such that the velocity of the water is gradually decreased. The fourth intake feeds water to that quarter of the wheel not connected with the scroll case. The division walls are all so arranged as to avoid eddies and swirls.

While the size of each intake varies throughout its length, the outer openings are each 7½ ft. wide by 22 ft. high, thus giving long, narrow gates sliding in cast-iron guides. Alignment of these guides, as

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well as the bearing on the nose of the piers for the guard screens, was secured by the use of steel forms in molding the concrete. A traveling crane will be used to operate both gates and screens. The latter are held in place by a cast-iron T-section bolted to the buttresses. All structural steel will be removed when the screens are raised; that is, none of it will be permanently submerged. The screens are in 4 sections, 10 ft. 9 in. high, with 3 by 1½-in. bars spaced 6 in. apart, giving an opening equivalent to 75% of the gateway. Any ice which may enter through the ice fender at the head of the forebay or form in the latter, and all débris, will be deflected from the screen by submerged skimmer arches. Suitable ice-chutes are provided for disposing of any floating matter that may accumulate in front of the screens. The water wheels are gray iron castings.

The wheels are combined impulse and reaction turbines of the Francis type, designed for low head, ranging from 39 to 20 ft. and for a speed of 57.7 r.p.m. From the Holyoke tests of the models, the efficiency is assumed to be 86%. The over-all diameter of the runner is 16 ft. 2 in., and the vertical shaft is 25 in. diameter. The thrust bearing is provided with a set of rollers in addition to the usual high-pressure oil lubrication. Practically all of the bearings are above water and are accessible for adjustment. Easy and quick response to the governor action is assured by refinement in alignment and by the ball-bearing support of the rocker ring. The governor is sensitive to a change in load of 15 kw, which is 0.2% of the total normal load. The water-wheel castings were mounted in the shops on their sides in ball bearings and balanced with lead until a 5-lb. weight on the circumference would cause the 73-ton mass to rotate.

The wheel is placed between two heavy cast-iron foundation rings, which are separated by solid 8-in. bolts. Each foundation ring weighs 50 tons. To insure as perfect alignment as possible, each liner was erected on eight 3 by 3-ft. concrete pedestals, which temporarily took the place of the separator bolts. Steel screw wedges resting on the pedestals were used to bring the rings into their exact position. The surrounding concrete was then poured, and after it had been allowed to set for at least 8 weeks, platforms were built on the supporting ledge *L*, Fig. 1, and concrete blocks piled on them, overloading the upper ring about 100%. Only negligible settlement took place. The instrument work had been done so carefully that the bearing face of the supporting ledge was level within 1/16 in. This ledge had been left ⅛ in. high in the shop, and a specially designed boring mill, consisting of a supporting spider carrying a revolving tool holder for vertical and horizontal cutting, similar to mills used to finish the supporting faces for battleship turrets, was then used to bring the surface to within 0.001 in. of level. These refinements make it certain that the shaft will be vertical and that the bearing surfaces will be at right angles to it—conditions necessary for the satisfactory operation of the thrust bearing. The bosses for the separator bolts on the under side of the upper foundation ring were also milled by a special tool after erection, the distance being gauged from the supporting edge after it had been milled true.

The water from the wheels flows into draft tubes, which are 60 ft. long at their centre lines. At the wheels, the section is an 18-ft. circle, gradually opening out to an oblong section at the end. The velocity is gradually reduced in these tubes from 18 to 4 ft. per second. The quarter turn from vertical to horizontal is by an easy curve. The foundations of the draft tubes at their outlets are 25 ft. below the normal river bed, and the rock in the way has been removed by quarrying to form a tail-race. The latter is fan shaped in plan, expanding to great width at the down-stream end of the powerhouse, beyond which it will gradually disappear into the natural surface of the bedrock.

The speed of each turbine is controlled by 20 cast-steel guide vanes, 6 ft. 8¾ in. high by 3 ft. 4 in. wide, connected to a specially designed Lombard governor. Cranks at the upper ends of the vane-supporting shafts are attached by links to an operating ring, which is carried on ball bearings and revolves against rollers mounted on eccentric bearings for adjustment. Piston rods from two high-pressure oil cylinders are attached to the ring at the extremities of one diameter. The maximum stroke of the pistons is 19 in. and the 25-in. diameter oil cylinders under 200 lb. pressure, will develop a power of 250,000 ft.-lb. in two seconds. Each guide vane may be removed for inspection or repair by withdrawing its stem

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vertically, without disturbing other parts of the mechanism. Each vane is supported and its weight carried by a ball bearing at the top of the shaft. The bottom step bearing is lubricated from the top by a hole through the shaft.

The governor fly-balls and the pump furnishing oil for the thrust bearings are driven by a countershaft geared direct to the turbine shaft. This countershaft is fitted with special couplings to absorb vibration that might otherwise be carried to the governor head. Motor-driven triplex oil pumps furnish the oil to the governor cylinders under 200 lb. pressure.

The weight of the wheel shaft and the attached runner is carried to a coupling spool, by a roundabout key at the top, and a vertical key the whole length of the spool takes care of the torsional stresses. The thrust bearing is interposed between the coupling spool and a cone-shaped casting resting on the supporting ledge of the upper foundation ring, as indicated in Fig. 1. The bearing itself, which is spherical, is provided with both rollers and an oil-pressure chamber. Normally, the weight will be carried by the oil, but any material drop in pressure or quantity of oil will permit the shaft to settle down onto the rollers, which are always immersed in oil and ready for operation. A special point made in the design of the wheel is that all lubricating devices and all bearings with the exception of the steady bearings of the guide vanes are out of water and accessible.

FIG. 2. PLAN OF THE KEOKUK PLANT.

The alternators, which are being furnished by the General Electric Co., are of the revolving field type with rotors 25 ft. 5 in. diameter. Each generator has a normal rating of 7500 kw. at 57.7 r.p.m. Three-phase 25-cycle alternating current is made; it leaves the generator at a pressure of 11,000 volts and is stepped-up to the line voltage of 110,000 by individual oil and water-cooled transformers, placed in cells behind the generating units. The rotor complete weighs 75 tons. The machines were shipped in sec-

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tions and are being wound and assembled for the first time at the plant. There are 456 individual coils or windings in each armature. The outside diameter of the completed generator is 31 ft. 5 in.; its height at the rim is 7 ft. 2 in., and 11 ft. 3 in. at the centre.

The revolving field spider is cast with 12 arms and a wide rim, like a heavy flywheel. The coils are bolted to this spider.

Excitation current for the generators will be furnished by two 1500-kw. units. Each unit consists of a 2200-hp. vertical turbine and generator, similar in general design to the main installations, together with a motor-generator set delivering direct current. The usual array of oil switches, disconnecting switches, and remote control apparatus completes the electrical equipment. The switching mechanism is on the second floor of the powerhouse, above the screen-room. The generator-room is served by two 150-ton Alliance cranes of 60-ft. span. The transformer-room is also served by heavy traveling cranes.

Since the powerhouse occupies a large area in what was formerly the middle of the river, it was necessary to build a coffer-dam covering about 35 acres before construction work could be commenced. This coffer-dam is composed of 16 by 24-ft. timber cribs, which extend about 15 ft. above the river bed. Each crib contains about 22,000 ft. of lumber and is held in place by loose rock. The cribs are made water tight by sheet piling faced with clay.

In addition to the dam and powerhouse, it was necessary to construct a large lock and drydock to preserve the interests of navigation. The lock is 110 ft. wide and 400 ft. long inside, with a lift of 40 ft. The drydock is 150 by 463 ft. This portion of the work involves no unusual features. The lower lock gates, which are of the miter type, were fabricated by the Chicago Bridge & Iron Co., Chicago. Each gate has a span of 115 ft., and the pivots are hardened steel working in bronze bushings. Compressed air, furnished by two small turbine units, will be used to operate the lock and drydock machinery.

The construction work is under the supervision of Hugh L. Cooper, vice-president and chief engineer of the Mississippi River Power Co. B. H. Parsons, of New York, is the mechanical engineer. The construction work is carried on by two separate and distinct organizations, the Illinois division, under Dexter P. Cooper, superintendent, building the dam, and the Iowa division, under H. T. Herrick, superintendent, constructing the powerhouse, lock, etc. The electrical work is in charge of the Stone & Webster Engineering Corporation of Boston, and when the plant is finished it will be placed in the hands of the Stone & Webster Management Association for management and future operation.

A Proposed State Law Dealing With the Manufacture of Portland Cement

[An act to protect the health of persons employed in the manufacture, packing, or handling of portland cement, has been introduced in the California state legislature, and is known as Assembly Bill No. 75. This bill if enacted into a law will effect vitally every development and industrial project within the state of California. Cement even more than steel has become a necessity to every individual in the land, and no one can afford to disregard the effect that the passage of this bill would have upon all the industries of the state.—EDITOR.]

THE people of the state of California do enact as follows:

Section 1. In any factory or other place in the state, where portland cement is manufactured, packed, or handled, provision shall be made for preventing the escape of cement dust into the atmosphere of any room or compartment where people are employed.

Sec. 2. The packing of portland cement shall be carried on in compartments which shall be separated by dust-proof walls, floors, and partitions from all other parts of the factory or establishment, where people are employed, and all conveyors and elevators used for the conveyance of portland cement shall be enclosed in metal or some other dust-proof material.

Sec. 3. All portland cement manufactured in the state, or imported from any other state or foreign country shall be packed in

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dust-proof containers, and the commissioner of the Bureau of Labor Statistics shall have the power to issue orders to prevent the loading or unloading of any portland cement in or for any vessel in any port in the state of California, or in or for any freight cars, or any railroad or railway in the state of California if such portland cement is not packed in a dust-proof container, and any person, firm or corporation who shall disobey such order shall be guilty of a misdemeanor. This section (No. 3) not to take effect until six months after passage.

Sec. 4. All contracts entered into by this state or any political subdivision thereof, for the purchase of portland cement or other like commodity or for the construction of public work which requires the use of portland cement, shall contain a proviso that all cement to be furnished in the construction of such public work shall be packed in dust-proof containers.

Sec. 5. Any person, firm, or corporation who shall violate or fail to comply with the provisions of this act, shall be guilty of a misdemeanor, and shall, upon conviction thereof, be punished by a fine of not less than fifty dollars or more than two hundred dollars, or by imprisonment for not more than sixty days, or by both such fine and imprisonment.

Sec. 6. The commissioner of the Bureau of Labor Statistics shall enforce the provisions of this act.

Measuring Air Discharge of Compressors*

By E. A. FESSENDEN

THIS is a brief account of a method of measuring the volume of air delivered by a compressor which I have often successfully employed. Only one tank is required and this may be the receiver tank which often forms a part of the compressed-air equipment. If such a receiver is not a part of the equipment, any reasonably tight tank will answer the purpose if it is strong enough to hold the normal delivery pressure of the compressor safely. A few small leaks will not affect the results in any manner whatever.

The arrangement of the tank is shown in Fig. 1. The outlet pipe contains a tee for a

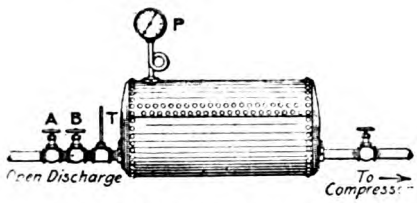

FIG. 1. AIR TANK FOR MEASURING DISCHARGE.

thermometer cup *T* and two valves *A* and *B*. A carefully calibrated gauge is provided to read the pressure of the air in the tank. If the regular receiver is used, the outlet pipe may be the ordinary service pipe, but when a test is to be made, it must be disconnected from the service lines so as to discharge directly into the atmosphere through the two valves *A* and *B*. There should be a valve between the tank and the compressor. All other outlets from the tank should be closed off.

When ready for a test, first open valves *A* and *B* wide. Then with the compressor running at its usual speed, gradually close valve *B* until the pressure in the tank remains constant at the normal working discharge pressure of the compressor. The compressor will then be running under normal operating conditions. After allowing the compressor to run in this condition for a short time to insure that all conditions have become constant, close valve *A* tight and allow the pressure in the tank to rise to 10 or 15 lb. above the normal working pressure. Then close the valve between the tank and the compressor and stop the latter.

Open the valve *A* quickly and take simultaneous readings of time and pressure as the pressure in the tank falls, due to the escape of air through the valve *B*. The best way to do this is to have an assistant hold a watch and call 'read' at uniform intervals of 15 or 30 seconds. The exact pressure should be read at the instant the signal is called. Continue this until the pres-

*Abstract from *Compressed Air Magazine*, January 1912.

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sure has dropped considerably below the working pressure.

Plot the readings just taken on cross-section paper so as to obtain a curve of pressure against time as illustrated in Fig. 2.

From the thermodynamics of gases we have the general equation for any gas,

$$PV = WRT \tag{1}$$

in which

P = Absolute pressure in pounds per square foot;

V = Volume of gas under the pressure P, in cubic feet;

W = Weight of gas present in pounds;

T = Absolute temperature of the gas in degrees Fahrenheit;

R = Constant = 53.35 for air.

Equation (1) can be written as

$$W = \frac{PV}{RT} \tag{2}$$

In the case under consideration W, P, V, and T represent the weight, pressure, volume, and temperature of the air in the tank at any time. The volume and the temperature remain constant, and the pressure and weight decrease as the air escapes through the partly open valve B. The volume considered is the entire volume of the tank and all connections between valve B and the valve between the tank and compressor. This can be determined by filling the tank and connections with water, weighing the water required, and calculating the volume by dividing by 62.355, the weight of 1 cu. ft. of water at 62° Fahrenheit.

Differentiating equation (2) with respect to time gives

$$\frac{dW}{dt} = \frac{V}{RT} \times \frac{dP}{dt} \tag{3}$$

in which $\frac{dW}{dt}$ is the rate of decrease of weight of air in the tank, or in other words, the rate of discharge, in pounds per second, while $\frac{dP}{dt}$ is the rate of decrease of pressure.

In Fig. 2 let M be a point on the pressure-time curve corresponding to the normal working pressure of the compressor. Draw the line MN tangent to the curve at M (this must be done carefully). Draw the line MK parallel to the pressure axis. Then

$$\frac{dP}{dt} = \frac{MK}{KN} \tag{4}$$

The values of MK and KN are read in pounds per square foot and seconds directly from the figure.

If the value thus obtained for $\frac{dP}{dt}$ is introduced into equation (3) the rate of discharge in pounds per second is found directly. Since the weight discharged must be the same as the weight drawn into the compressor, the free air capacity is found by the formula

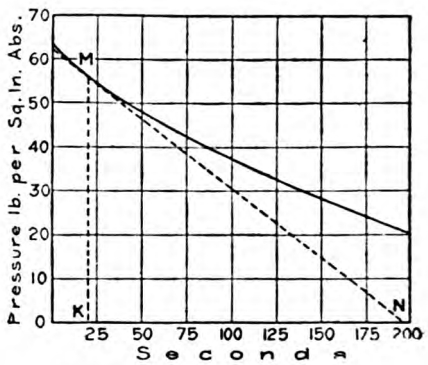

FIG. 2. PRESSURE-TIME CURVE.

$$V_0 = \frac{WRT_0}{P_0} \tag{5}$$

where V_0 is the volume in cubic feet of air per second at the intake pressure P_0 (in pounds per square foot absolute) and at the absolute temperature T_0 and W is the weight of air discharged per second just found from equation (3).

To illustrate this method, consider Fig. 2 to be the pressure-time curve of a small compressor delivering air into a tank which with its connections has a volume of 47.7 cu. ft. The temperature of the air in the tank at the time the test was made was 87°F. or 547° absolute. It was desired to find the amount of air discharged against a pressure of 56 lb. per sq. in. absolute. Thus the line MK represents 56 lb. per sq. in. or 8064 lb. per sq. ft. From the figure KN is 194 −20 = 174 sec. Then

$$\frac{dP}{dt} = \frac{MK}{KN} = \frac{8064}{174} \text{ lb. per sq. ft. per sec.}$$

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From equation (3)

$$\frac{dW}{dt} = \frac{47.7}{53.35 \times 547} \times \frac{8064}{174}$$

$$= 0.0758 \text{ lb. per sec.}$$

At atmospheric pressure and 32°F. the volume of air passing into the compressor is

$$V_0 = \frac{WRT_0}{P_0} = \frac{0.0758 \times 53.35 \times 492}{14.7 \times 144}$$

$= 0.9391$ *cu. ft. per sec.* $= 56.346$ *cu. ft. per min.*

When accurate results are required, it is well to repeat readings for the pressure-time curve several times and take the average value of $\frac{dP}{dt}$ thus obtained. It is, of course, important that the pressure-gauge and thermometer used be carefully calibrated, and that the temperature of the air remain the same when the readings for the pressure-time curve are taken as when the valve *B* is adjusted. After once adjusting valve *B* it must not be disturbed until the test is finished.

This same scheme can be used to provide a constant load on a compressor for an economy test. It is only necessary to adjust the valve *B* to give the discharge pressure desired and then run the compressor continuously at the proper speed, allowing it to discharge into the tank and the air escaping through valve *B*. As long as the pressure and temperature of the air in the tank are constant, the rate of discharge is constant. The compressor governor should be adjusted to keep the speed constant and the pressure will remain constant as long as the valve *B* is unchanged. The temperature of the discharged air is practically dependent upon the amount and temperature of the jacket-cooling water. If these are kept constant the air temperature will not change appreciably. The compressor is then allowed to warm up thoroughly, so that all these conditions become constant and the test is begun by adjusting valve *B*, thus fixing the rate of discharge as determined from a pressure-time curve. The load will now remain constant and the readings of steam pressure, steam weight, indicated horse-power, etc., are taken in the ordinary way.

The method outlined above has several advantages: It is rapid, simple, practically and theoretically correct, and can be made very accurate if care is taken in making the readings and in plotting the pressure-time curve. It is flexible and can easily be adapted to widely different conditions of operation. All leakage and friction losses are taken into account. No expensive apparatus is required and often not even a change in piping. The manipulations and calculations are easy.

The Cementing Process of Excluding Water From Oil Wells, as Practised in California *

By RALPH ARNOLD and V. R. GARFIAS

THIS preliminary paper is published by the Bureau of Mines as one of a series dealing with the important problems relating to the technology of petroleum, with especial reference to lessening waste in the exploitation of oil deposits on or adjacent to public lands, and increasing efficiency in the use of fuel oil by the Government. Most of the information has been furnished by oil operators, among whom may be mentioned Thomas O'Donnell, W. A. Williams, W. R. Hamilton, R. S. Hazeltine, T. Crumpton, R. C. Baker, J. M. Wells, E. W. Stow, Chester Naramore, and J. M. Robertson. To these gentlemen, and many others, the writers wish to extend their thanks for hearty coöperation.

One of the most important problems connected with the economical recovery of oil is that of the permanent exclusion of the water before or after the oil reservoirs are reached. As one of the most experienced operators in California forcibly expresses it, "The oil industry is the most important water business in the state." In California the exclusion of water has been accomplished

*Abstract from Technical Paper 32, Petroleum Technology 3, Bureau of Mines.

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in a number of ways, determined by local conditions, but so far the most uniformly successful method is the cementing process, which is used with slight modifications throughout the 11 principal districts of the state. Although in some wells, cement or cement-grout is used between the casings in order to form an impervious packing, which stops the inrush of water, this expedient is employed only in extreme cases, and, as can be readily understood, does not affect the migration of oil or water through the strata penetrated by the wells. To prevent the flooding of the oil sands by the waters above or below, it is necessary to force the cement into the space outside the casing in order to form a water-tight bond between the casing and the walls of the hole.

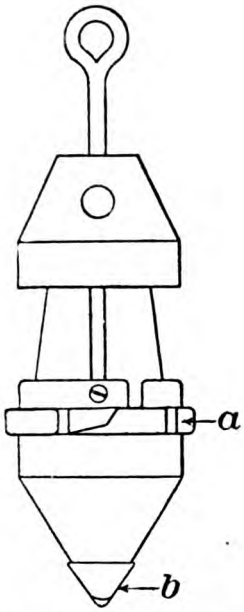

FIG. 1. A CEMENT PLUG.
a SLIPS. *b* VALVE.

The details of the operation vary with the position of the water sands in relation to the oil-bearing beds, it being comparatively easy to 'case off' waters occurring a considerable distance away from the oil zone, and proportionately harder to exclude water immediately over, between, or below the oil-bearing sands. These difficulties are greatly magnified with the increased depth of the wells. The porosity of the formations penetrated, the different gravities of the oils, and the varying gas and hydrostatic pressures affecting the oil or water are also important factors having a direct bearing on the problem of shutting out the water.

The number of water sands penetrated before the oil-producing zone is encountered varies, being usually from one to five. In some fields there exist two or more distinct oil zones, and a water sand sometimes occurs between these oil zones, in which case the cementing operation becomes doubly important, as the greatest care must be exercised in order to effect the recovery of the oil from these different sands without admitting the intervening water. Oil zones situated as those referred to above are found in the Coalinga-Westside field, where it has been impossible to produce simultaneously from the 'light' and 'heavy' oil-sands without encountering considerable trouble with the water lens that in places occurs between them. The general practice at present is to exhaust the upper sands before tapping the deeper ones.

Although there are many processes of cementing in use, which differ as to minor details, the operation is in general accomplished in two ways: (1) by pumping the cement mixture through the tubing, whence, unable to flow back between the tubing and the casing, it is forced outside the casing; or (2) by lowering the cement mixture in a dump bailer, and forcing it to the outside either by means of a plunger driven down with the aid of water under pressure, or with a plug fitted to the end of the casing. The first-mentioned method is commonly known as the pump method, and the devices used for the latter, according to detail, are variously designated by the names of inventors, as the Perkins cement plunger, or the Baker cement plug.

Previous to discussing specifically the two processes mentioned above, the following recommendations and suggestions are presented. These should be observed, irrespective of the process employed, in order to accomplish a successful cementing operation:

1. A careful study of the well records in all neighboring wells should be made in order to understand the underground conditions of the immediate territory, before it is decided at what depth or in which formation the casing should be 'landed' and cementing undertaken.

2. The condition of the hole should be such as to allow the free lowering and rais-

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ing of the casing, thus assuring between it and the walls of the hole a space through which the cement mixture may move or circulate before the initial setting takes place. It is usually a good plan to under-ream the lower 30 or 40 ft. of the hole, thus facilitating circulation and the formation of a thick protective layer of cement around the lower portion of the casing.

3. The well should be cleaned of all débris and mud, and enough clear water should be pumped in to wash out any sulphur or alkaline water.

4. It should be ascertained by the use of a casing-tester or other effective means whether the casing leaks.

5. Previous to cementing, some definite information should be gained relative to the action of the water in the hole on the setting qualities of the cement. If the action is detrimental, a chemical analysis of the water should be made with the intent of ascertaining and perhaps correcting the deleterious effect of the particular salts in solution. An excess of gypsum in the water might delay the setting of ordinary cement three to four months. To meet this condition a quick-setting cement should be used. Considerable quantities of alkali in flowing water may destroy or disintegrate cement.

6. Whatever the composition of the water in the hole, it is of the utmost importance that the water used for mixing with the cement be as pure as possible, preferably condensed water from the boiler, as the character of the water will have a controlling effect on the subsequent behavior of the mixture. If the water is warm the time of setting will probably be shortened. In all cases the mixture should be as thick as can be conveniently handled under the circumstances.

7. As the initial setting of cement under ordinary conditions takes place in about 2 hours after the mixing with water, this time will, to a certain extent, limit that employed in the operation, but as the mixture remains comparatively soft for 2 hours longer, the cement may possibly be pumped during the third or fourth hour after mixing if greater pressure is exerted.

8. Although no appreciable change occurs in the cement after being allowed to set for about 2 days, the hole preferably should not be disturbed for 2 weeks, during which time the pressure maintained should be as nearly as possible that used during the cementing. In one well, however, where the ordinary precautions were used, the cement was found to be in a fluid condition and was readily pumped out after remaining in the hole for 13 days.

9. In shallow wells it may sometimes be advantageous to pump in cement until it reaches the surface, an indication that all cavities are filled, and that when the cement shall have set, it will form a protective coating around the casing for its full length. Such a procedure is also advisable in any well where the waters are of such character as to corrode the casing quickly.

10. The approximate quantity of cement to be used should be carefully ascertained after a close study of neighboring operations. If the quantity be too small, the result will be unsatisfactory, and if the pumping be done indiscriminately, the expense will be increased without improving the chances of accomplishing a successful job.

11. After the cement has been pumped into the hole and the casing lowered to the bottom, all the mixture that remains inside the casing should be bailed out as soon as possible before it sets, as the subsequent drilling of such a cement core is difficult and is responsible for many of the failures in cementing wells, the jar from the heavy tools causing the cement outside the casing to crack.

12. After the cement has been allowed to set a sufficient time, the water should be withdrawn, the operation being gradual in order to avoid the possible collapse of the casing or the jamming of considerable loose material on the bottom from the inrush of the outside water, if the cementing operation has not been successful. By pumping the water, say one-third at a time, at intervals of 12 hours, any sudden inflow will be readily noticeable by the rising of the inner water level, and this rising water will tend to equalize the hydrostatic pressures outside, and thus prevent the collapse of the casing. Should the well be a comparatively shallow one, the pressure of the outside water will not be sufficient to cause the failure of the casing, so that it may be advisable to keep the hole bailed dry from the beginning. In order to ascertain whether the water has percolated through holes in the casing itself, a casing-tester may be used. This consists of 2 or 3 joints of tubing open above and closed at the lower end, and having bolted at the open end a ring of belting of such

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diameter as to fit snugly into the casing. The tester is lowered with the sand line, say, 500 ft. at a time, and withdrawn to observe whether any water has collected in the tester throughout that distance, and by repeating the operation it can be ascertained whether the casing leaks, and if so, at what place.

13. In general, most of the failures of the cementing operation can be attributed to improper circulation on the outside of the casing, poor quality of cement, the deleterious effect of salt waters on good cement, lack of sufficient pressure in the pump to overcome unforeseen obstacles, or, where gas has been encountered below the place where cementing is to be undertaken, to the improper exclusion of the gas, a condition that will keep the cement above constantly agitated and prevent it from setting.

The procedure in connection with the pump method is as follows: After the space between casing and tubing has been filled with water, and after the fact that the casing can be lowered and raised without difficulty has been ascertained, the casing is hung 6 to 24 in. above the bottom. A column of tubing, to the lower end of which is attached a reducer or a T joint, is lowered to about 2 ft. above the casing shoe and connected to the pump. Enough water is then forced down to indicate whether it will circulate freely between the outer casing and the wall of the hole; the water also serves to remove whatever slush or alkaline water remains in the well. Before pumping stops, the casing is lowered to the bottom to test whether the bond between the casing and the material upon which the shoe rests is water-tight and whether the casing leaks or not. If the casing is sound, the pressure against which the pump is working will immediately increase.

Seven hundred pounds of cement mixed with about 16 bbl. of water is sometimes enough for a successful cementing job in wells 900 to 1200 ft. deep, whereas in other wells as much as 25 tons is necessary properly to protect the hole. The mixture is made in a shallow wooden tank and is pumped continuously until all has been used, when the pump is disconnected to allow the inserting of a wooden plug into the tubing. The plug is then driven down by additional pumping. The plug forces the cement ahead until it reaches the reducer at the lower end of the tubing and so drives all the cement to the outside of the casing. The pressure is kept constant while the casing is being lowered to the bottom, after which the pump is disconnected, the tubing pulled out, and whatever mixture remains in the hole is immediately removed with a bailer.†

In some wells drilled by the rotary method, it is advisable to pump the cement into the casing, which has been perforated for some distance above the rotary bit to allow the escape of the cement to the outside. The cement is then poured into the casing and forced down with a wooden plug propelled with the aid of the pump. The water below the cement passes through the perforations to the outside, the cement following. When the upper plug reaches the closed end of the casing all the cement has presumably been driven out.

In the best practice a pump capable of maintaining a pressure of 700 or 800 lb. per sq. in. is provided for use with the pumping method. Although this pressure is seldom required to force the cement in, the pump is powerful enough to overcome the difficulties that sometimes arise.

The cement plunger has been found very effective in the cementing of many wells. Among the advantages that can be claimed for it, is that no tubing is required in connection with its use. The following description gives an idea of how the plunger is used.

After the fact that the casing is free and the circulation is established has been ascertained, the casing is pulled up about 2 ft. from the bottom and about 10 bbl. of clear water pumped in to wash out any slush or mineralized water that may have accumulated in the lower portion of the hole. The circulating head is removed and two iron discs, connected by a cast-iron stem about 2 in. diameter and 3 ft. long, are placed in the casing. These discs have a diameter about ¾ in. smaller than that of the casing. A ring of rubber belting attached to the rim of each makes it fit the casing snugly, and keeps the cement from forcing its way past and mixing with the water already in the hole. The mixture is pumped into the

†J. M. Wells, who has been successful in cementing comparatively shallow wells in the Coalinga-West Side field by the above method, informs the writers that as a rule no more than a bailerful of cement is removed after the casing has been landed.

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casing, forcing the discs down, and after the cement has all been pumped in, the cap on the circulating head is again removed and another iron disc put in, similar to the ones already inserted, except for a cup-shaped leather follower which fits snugly in the casing and is attached to it at the top. The cap on the circulating head is then put in place and water pumped into the well, forcing the whole column of water and cement down until the lower disc reaches the bottom of the hole, leaving the uppermost disc about 1 ft. inside the casing. The pressure from the pump forces the cement past the pliable washer attached to the upper disc. The pumping is continued until the upper disc is forced down on top of the one already at the bottom; the leather follower attached to the top of this disc being cup-shaped expands under pressure to the side of the casing, blocking the discharge. The pressure gauge on the pump immediately indicates that the cement is all out of the casing. Double assurance that the cement has all been displaced by the water may be had by measuring the water pumped into the hole after the cement. The bailer should be used in a couple of days to remove any cement that may have slipped past the discs at the inside of the casing. The discs, being of cast iron, are easily drilled out afterward. The time required in this process for the cementing operation proper is only about 1 hour.

The cement plug is shown in Fig. 1. When this device is to be used in connection with cementing a well, the cement mixture is either conveyed to the bottom of the 'open' hole by a dump bailer or, if the formation is apt to cave, the mixture is dumped in while the casing rests on the bottom and the casing is subsequently pulled out of the cement.

After it has been determined that there is no cement in the casing, the cement plug is hung by a soft rope from a bailer. As the bailer is lowered down the hole, the slips (a, Fig. 1) on the plug slide upward, thus allowing the plug free passage. When the plug strikes the water the weight of the bailer on the valve stem causes the valve b at the bottom of the plug to open, thus allowing the water to pass through and the plug to descend freely. When the plug passes out of the casing the slips drop, and if a slight tension is exerted on the sand-line the plug is brought against the casing shoe and the slips catch thereon, closing the valve and furnishing the casing with a closed pointed end that effectually prevents the passage of any material back into the casing. The casing is then lowered into the cement with enough strain on the bailer to hold the plug tight against the shoe, but not enough to break the soft rope between the bailer and the plug. Care must be exercised in this operation to see that the bailer is lowered with the casing, otherwise the tie between the bailer and the plug may break and the plug fall into the open hole.

As soon as the casing has been set into the cement and will go no farther, the bailer is jerked loose from the plug and pulled out; then, if the weight of the casing is not sufficient to cause it to settle through the cement to the bottom of the hole, the casing may be driven down. The valve in the plug being closed and the slips fitting tight in the shoe, none of the cement can go back into the casing, and it will therefore be forced into the formation or up the hole on the outside of the casing. The plug, being made of cast iron ½ in. thick, can be easily drilled out.

One of the advantages of the method of lowering the cement to the bottom of the casing before forcing it out is that the cement can be mixed thicker than under the pump methods; consequently a smaller quantity is needed. In many cases it is advisable to cement and test certain formations before going deeper. Under this method, as not so much cement is used, the subsequent loosening of the casing would probably be easier should removal be desirable for any reason after the cement is in place.

Improvement of Pole Preserving Methods

THE U. S. Forest Service has just finished the treatment of 450 telephone poles by the Boucherie process. This process has been used with great success in France and Germany for many years, but has not been given a good trial in the United States. The preservative used was a solution of copper sulphate, or ordinary bluestone, and its manner of injection was unique. Freshly cut poles were treated with the bark on. A

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chamber was formed at the butt of the pole, by putting on a ring of packing, and clamping a board over it. The preservative was forced from a hose through a hole in the board, and passed through the pole from end to end. The necessary pressure was developed by the weight of the solution, which was stored in a tank 28 ft. above the ground.

The treatment required about three days, and, when completed, the whole sapwood was filled with the preservative. It is very difficult, if not impossible, to get such a penetration by any other process. The treated poles are being used in the construction of telephone lines on the Tahoe national forest, and the result of the treatment carefully watched. It is expected that the poles will last from 12 to 15 years, which is the usual length of service in Europe. Untreated poles cannot be expected to last longer than 3 years.

The process is expected to be especially valuable for treating poles in mountainous country where the cost of freighting plant and preservative now prohibits the use of the creosote process. The plant required for the Boucherie process is so simple and compact that one large enough to treat twenty poles at a time could be packed on a couple of burros. The bluestone is shipped in dry crystal form and can be carried in packages of any description.

Practically any kind of timber can be treated. The species treated by the Forest Service were Western yellow pine, white fir, incense cedar, Douglas fir, and sugar pine. One California company plans to erect a plant in the spring to treat its telephone poles. The Forest Service has some interesting data on the process at its offices in the First National Bank building, San Francisco.

Oil for Macadam Roads*

By E. A. JAMES†

AUTOMOBILE traffic has revolutionized our ideas of permanent road construction. A dozen years ago a well constructed water-bound macadam road was considered about as permanent a road as could be desired for country traffic. With the constantly increasing use of the high-speed rubber-tired automobile, however, such roads have in many cases disintegrated faster than they could be maintained.

COST, PER APPLICATION, OF OILING ONE MILE OF ROAD, OF DIFFERENT WIDTHS WITH VARYING QUANTITIES OF MATERIAL. OIL, 7½C. PER GALLON. COST OF APPLICATION $25 PER MILE.

Width of road, feet	Square yards per mile ...	¼ gallon per square yard.	½ gallon per square yard.	¾ gallon per square yard.	1 gallon per square yard.	1¼ gallons per square yard
10....	5,867	$135	$245	$355	$465	$575
12....	7,040	157	289	421	553	685
14....	8,213	179	333	487	641	795
16....	9,387	201	377	554	729	905
18....	10,560	223	421	619	817	1,015
20....	11,733	235	465	685	905	1,125

OIL, 8½C. PER GALLON. COST OF APPLICATION, $25 PER MILE.

Width of road, feet	Square yards per mile ...	¼ gallon per square yard.	½ gallon per square yard.	¾ gallon per square yard.	1 gallon per square yard.	1¼ gallons per square yard.
10....	5,867	$150	$275	$400	$525	$650
12....	7,040	175	325	475	625	775
14....	8,213	200	375	550	725	900
16....	9,387	225	425	625	825	1,025
18....	10,560	250	475	700	925	1,150
20....	11,733	275	525	775	1,025	1,275

Ordinarily, the following applications will suffice:

First Year—First application, ½ gal. per square yard; second application, ¼ gal. per square yard.

Subsequent Years—Two applications, each ¼ gal. per square yard.

It has been clearly demonstrated that the bond in ordinary macadam road is insufficient to protect it against the somewhat complex action of the automobile tire traveling at high speed. The dust raised by this

*Abstract from *Applied Science*, January 1913.

†Chief Engineer York Highway Board.

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class of vehicles is blown entirely off the road and a fresh lot of dust raised, this repeated action resulting in the wearing down of the road surface, in some cases several inches in a single season.

While oiling a road is not considered a permanent remedy for this disintegration, it serves to keep the dust down, thus preventing the next lot of dust being raised, and by this means temporarily preserving the road. There are many varieties of oil on the market for this purpose, some of which are little better than water, while others, having a bituminous base, on the evaporation of the volatile constituents, leave a certain amount of bitumen to act as an aid to the binder in the road. This bituminous residue is increased at each successive application, so that as time passes, the applications may be made fewer and lighter.

The cost per year of applying oil at current prices amounts to 8 to 15% of the original cost of the road if built by day labor, or 5 to 10% if built by contract. The expenditure will be well repaid in the elimination of the dust nuisance and the decreased cost of maintenance, as well as in the increased life of the road.

Company Reports

The Standard Oil Co. of California reports assets and earnings as follows:

Assets:	
Plant	$38,241,000.57
Other investments	190,750.00
Inventories	19,246,014.23
Accounts receivable	4,317,777.68
Cash	972,502.67
Cash equivalent loans on call, secured by collateral	4,347,857.75
Total	$67,315,902.90
Liabilities:	
Cap. stk. auth. $50,000,000.00	
Less treas. stk. 5,066,006.33	
Cap. stk. issued	$44,933,993.67
Accounts payable	2,185,906.88
Surplus invested as above	20,196,002.35
Total	$67,315,902.90
Net earnings for 1912	$7,106,156.17
Dividends paid during year	1,123,348.83
Balance carried to surplus	$5,982,807.34

Puget Sound Traction, Light & Power for 1912 earned a surplus over all charges of $1,565,299, or about 2½ times the dividend requirements for its $10,961,700 6% preferred stock. The balance after preferred dividends is equal to 4.8% on the outstanding $20,000,000 common stock.

Dividends now being paid on the common stock are 1% quarterly, and, while the surplus for 1912 was less than 1% above these dividend requirements, it is expected that in 1913 a much larger surplus will be shown for the common, as current earnings are making satisfactory gains, and the territory served by the company is increasing rapidly in population. The company does practically all the electric, street, and interurban, and light and power business in the Puget Sound district, including the cities of Seattle and Tacoma.

Portland Railway, Light & Power Co., operating street railways and electric lighting and power business, and electric interurban traction lines in Portland and vicinity, has planned quite an extensive program of betterments and extensions for the present year. In all, the improvement program will require an expenditure of $4,000,000, of which $2,500,000 will be used for railroad construction, new buildings, equipment, repairs, and other betterments in the city and suburban railway lines. For betterments and extensions to the light and power system of the company, $1,500,000 will be expended.

The Mill Valley & Mount Tamalpais Scenic Railway Co., the corporation now owning the railroad to the summit of Mount Tamalpais, and the Mount Tamalpais & Muir Woods Railway, recently organized, have joined in an application to the Railroad Commission for permission to sell the property of the old to the new company. The new company is incorporated with a capital stock of $500,000 and by the terms of the sale that have been arranged by the two companies, the stockholders in the old company will get $300,000 of this stock for their holdings. The old company is incorporated for $200,000. The new company assumes all the outstanding indebtedness of the old company. It is

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proposed to sell enough of the $200,000 of stock remaining in the treasury of the new company, after buying out the old company, to make several improvements. The road is to be extended to Bolinas and to other points of interest in Marin county. The incorporators of the new company are James K. Lynch, Frank F. Bostwick, Charles T. Crocker, Charles E. Green, R. H. Pease, Jr., Kenneth C. Gillis, and N. E. Fitzpatrick. According to the statement for 1912, the road transacted business as follows:

Railway operating income	$71,004.66
Railway operating expenses	31,327.66
Railway net	$39,677.02
Tamalpais Tavern net	2,040.53
Muir Inn net	57.27
Total net	$41,774.83
General expenses	28,280.24
Gain on operations	$13,494.59
Other income	8,286.85
Total gain	$21,781.44

The balance sheet on December 31 was as follows:

Assets:	
Construction	$286,678.35
Equipment	102,373.66
Inventories	14,162.10
Cash	3,010.46
All other	86,016.49
Total	$492,281.06
Liabilities:	
Capital stock	$200,000.00
Mortgage bonds	100,000.00
Gold bonds	30,500.00
Bills payable	31,000.00
Sundry creditors	5,956.88
Surplus	124,824.18
Total	$492,281.06

A comparative statement of the earnings of the *Mount Whitney Power & Electric Co.* for the month of January 1913 shows an increase in both gross and net earnings over the corresponding month of 1912. The company reports for January as follows:

	1912.	1913.
Gross earnings	$34,026	$39,103
Oper. expenses and taxes	14,667	16,809
Net earnings	19,359	22,294

The San Joaquin Light & Power Co. has reported for January and the 6 months ended January 31, showing an increase for the month of 108.07% in net surplus applicable to preferred dividend, and an increase for the period of 199.76% in net surplus. The company reports as follows:

Month ending Jan. 31—	1912.	1913.
Gross income	$108,573.74	$142,175.43
Operating expenses, maintenance, and taxes	46,279.32	52,738.78
Net income	$ 62,294.42	$ 89,436.65
Int. on bonds, int. on funded debt	32,266.98	33,008.70
Balance	$ 30,027.44	$ 56,427.95
Accrued sinking fund and bond discount.	5,797.29	6,010.64
Net surplus	$ 24,230.15	$ 50,417.31
Six months ending Jan. 31—		
Gross income	$575,938.76	$786,445.67
Operating expenses, maintenance, and taxes	270,095.52	284,608.03
Net income	$305,843.24	$501,837.64
Int. on bonds, int. on funded debt	181,823.81	197,260.21
Balance	$124,019.43	$304,577.43
Accrued sinking fund and bond discount.	34,086.17	34,986.37
Net surplus	$ 89,933.26	$269,591.06

Sierra Pacific Electric reports as follows:

	1913.	1912.
January gross	$ 55,520	$ 52,347
January net	28,777	30,624
Surplus over charges	22,899	25,182
12 months gross	638,070	575,861
12 months net	396,446	346,844
Surplus over charges	330,021	308,834

The California Petroleum Co. and its subsidiaries report for January: Gross earnings, $248,500; net earnings, after all interest and deduction of $13,600 sinking fund, $184,511. Of the latter 96.89%, or $178,772, is available for dividends on California Petroleum, or at the rate of 7% on the preferred and approximately 9% on the com-

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mon. In addition to the above, the California Petroleum Co.'s surplus increased approximately $4000 in January through the purchase of bonds for the sinking fund at a discount.

The Southern California Edison Co. reports for the year ended December 31, as follows:

	1912.	Changes. Increase.
Gross earnings	$635,200	$180,200
Operating exp., taxes, etc.	359,797	101,776
Net earnings	$275,403	$ 78,424
Interest charges	160,948	25,708
Surplus	$114,455	$ 52,716
Number of customers	24,838	5,037

The Los Angeles Gas & Electric Corporation, all of the stock of which is owned by the Pacific Lighting Co., of San Francisco, has made its annual report for 1912. The features of the report are as follows:

Gas Department:

Total assets (inc franchise)	$15,972,910.61
Franchise	1,072,500.00
Liabilities	14,900,416.61
Operating income	2,927,340.92
Operating expenses	2,174,194.28

Services connected Dec. 31, 107,952.
New mains laid, 116.50 miles.
Gas sold by meter, 3,635,105,600 feet.

Electric Department:

Operating income	$1,357,468.52
Operating expenses	989,023.28
Total assets (inc. franchise)	5,463,094.28
Franchise value	357,500.00
Conduit system	580,124.09
Poles and wires	1,776,691.86

The final net of various California and Nevada railroads for the month of December 1912, with comparisons for December 1911, follows:

Railway.	December, 1912.	1911.
Yosemite Valley	$ 3,345	$ 2,366
Nevada Co. N. G.	1,493	3,026
McCloud River	214	5,570
Bullfrog & Goldfrog	211	132
Tonopah & Goldfield	26,123	16,750
Sierra	15,179	13,745
San Diego & S. E.	1,533	.....
Salt Lake Route	229,624	79,343
Virginia & Truckee	6,620	5,579

Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

THE California Railroad Commission has rendered a decision granting authority to the San Diego Consolidated Gas & Electric Co. to issue $106,000 of 6% debentures. The proceeds are to be used in discharging a portion of the company's existing indebtedness. The original application was for $500,000. The San Diego Consolidated, by the terms of its mortgage, may issue bonds up to 75% of the cost of betterments or additions to its property. In its application it asked for authority to pay the remaining 25% of the cost of its properties and the bond discount by means of the issue of debentures. The Commission took the view, however, that it would not allow a combination of bonds and debentures which would bring about fixed obligations in excess of the value of the property for which they were issued. The Commission found further that the San Diego Consolidated had paid out in the form of an extra dividend the sum of $255,600, a part of which, it was declared, could have been used to meet obligations due its only stockholder, the Standard Gas & Electric Company.

THE California Railroad Commission has rendered a decision granting the application of the Great Western Power Co. for authority to issue bonds to the amount of $4,411,000, the proceeds of which are to be used for the general improvement, extension, and development of the company's facilities, principally the completion of a dam on the Feather river.

The opinion requires that the dam shall be of the gravity section type, which will cost, it is estimated, $1,607,635.

The Commission in its decision declares that the general condition of the Great Western Power Co. will be bettered by the use of the proceeds from the sale of the bonds, but provides that the company shall make up the discount on its bonds, which are to be sold at 90, within a period of 10 years.

The money to be derived from the proceeds of the bonds is to be used as follows:

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New distribution lines and service connection to consumers in the counties of Alameda, Contra Costa, Sacramento, Solano, Sonoma, and Napa, and the cities and towns of San Lorenzo, Oakland, Berkeley, Oak Park, Sacramento, Sebastopol, Napa Junction, Suisun, Fairfield, Napa, Santa Rosa, and Dixon	$ 709,195
Construction of 15 miles of transmission lines from Moraga valley to the south side of Carquinez straits, a sub-station at the Carquinez end of the line, line between Valona and Richmond, transformer sets at Richmond, 6 miles of secondary circuit on Richmond feeder, primary extensions and transformers at Oakland, regulators at Oakland substation, an armored cable beneath the waters of San Francisco bay, auxiliary line from Napa to Santa Rosa, second circuit from Carquinez straits to Napa, additional armored cable beneath the waters of Carquinez straits, condenser at Oakland, generator set at Fruitvale	362,602
Extension of Big Bend power-house by completing installation of units 5 and 6 to increase the capacity from 40,000 to 60,000 kw.	639,627
Completion of Big Meadows dam and reservoir	1,607,635
Acquisition of lands in Big Meadows reservoir site	200,000
Antioch sub-station	46,000
Sacramento sub-station	20,900
Balfour-Guthrie extension	16,200
Antioch-Bowers tie line	10,000
Antioch-Sherman island tie line	9,000
Antioch-Nichols circuit	9,000
Island division extension	35,000

The balance will be devoted to general improvements over the entire system.

RECLAMATION DISTRICT NO. 900, YOLO COUNTY, CAL., has issued $456,000 in 6% bonds in denominations of $1000. This district is the property of the West Sacramento company and was created by a legislative act of the state of California, approved March 2, 1911. The district lies opposite the city of Sacramento, and is connected by two highway and railroad bridges, one owned by the Northern Electric Co. and the other by the Southern Pacific Co. The funds derived from this issue are to be expended by the district trustees for the reclamation of lands and protection from high water. The district includes 11,500 acres of uniformly rich alluvial silt, and development work is now in progress to prepare them for residential, industrial, and agricultural purposes. The district is served by the Southern Pacific Co., Sacramento & Woodland railroad, and river steamers, and will be served by the Vallejo & Northern, Oakland, Antioch & Eastern, and West Side railroad, all of which are under construction. Wharf construction will commence this year; road building and plowing has been practically completed. The main canal and two 100,000-gal. electrically operated pumps will be used for the control of any surplus water within the district. H. W. Furlong is the general manager of the West Sacramento Co. Haviland & Tibbetts, of San Francisco, prepared the engineering report upon which the bond issue was based.

THE CALIFORNIA, SHASTA & EASTERN RAILWAY CO. has applied to the Railroad Commission for authority to issue bonds in the sum of $797,000 and capital stock of the par value of $1,075,000 for the acquisition of the railroad from Anderson to Bella Vista, a distance of 16 miles, for its repair and construction, and for the construction and equipment of an extension of 13 miles from Bella Vista to Ingot. The line to Ingot will serve the Afterthought Copper Co., the J. E. Terry Lumber Co., and other industries.

THE Los Angeles Gas & Electric Corporation has applied to the California Railroad Commission for authority to issue $900,000 of bonds. The proceeds are to be applied to the following purposes:

Purchase of the Valley Gas & Fuel Co.	$175,000
Addition gas-generating set and new equipment	169,000
Extension of distributing system for new consumers	600,000
Extension of electrical distributing system	280,000

BY a vote of 3091 to 559, the electors of Riverside have registered their approval of the proposition to issue $1,160,000 bonds for the acquisition and construction of a municipal water plant.

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Book Reviews

THE ELEMENTS OF MACHINE DESIGN. PART II. By W. Cawthorne Unwin. Longmans, Green & Co., New York. Pp. 422, index. For sale by the *Mining and Scientific Press*, San Francisco. Price $2.50.

This is a revised edition of the second part of Mr. Unwin's well known work and deals chiefly with engine details. The first chapter gives a full discussion of pipes and cylinders, and covers not only the various types from a standpoint of strength and application, but gives general data concerning the flow of fluids and friction losses. The study of the design of engine details forms the principal feature, and the treatment of the subject is thorough and exhaustive. Indicator diagrams, kinematical and dynamical problems, and balancing are discussed with the author's usual clarity, while the design of the smaller details concerning reciprocating-engine design is given careful attention. Chapters on condensers, lubricators, and methods of lubrication round out the volume. Mr. Unwin's works are among the classics of mechanical engineering, and are held in high esteem throughout the engineering profession.

STEAM BOILERS. By E. M. Shealy. McGraw-Hill Book Co., New York. Pp. 350, index. For sale by the *Mining and Scientific Press*, San Francisco. Price $2.50.

This book is one of the engineering-education series prepared in the extension division of the University of Wisconsin at which Mr. Shealy is assistant professor of steam engineering. It is especially adapted for use in connection with correspondence instruction and for firemen and others who may be in charge of boiler-rooms. The subject is treated from the standpoint of operation rather than design. Various types of boilers and their characteristics are described at length. Formulæ for boiler calculations are given, as well as a discussion of heat and its effect, properties of steam, and evaporation. The discussion of fuel is somewhat disappointing from a Western standpoint by reason of the limited space given to petroleum as compared to that given to coal. Chapters on the inspection, care and testing of boilers are especially interesting to the elementary student and are quite as important as the fundamental principles of design and operation. As a whole, the book is well adapted to the purpose for which it was written.

THE GAS, PETROL AND OIL ENGINE. By D. Clerk and G. A. Burls. Vol. II. John Wiley & Sons, New York. P. 823. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $7.50.

The recent development of the internal-combustion engine has been so rapid that it is a difficult task indeed to do justice, under one cover, to all of the diversified fields of its application. This volume deals especially with the practical problems of design, construction, and operation. The opening chapters cover the fundamental theory and development of the four-stroke Otto cycle and the two-cycle gas-engines. The results of many tests are given and typical indicator cards are shown. Much of the data are taken from the experience of Crossley Bros., Ltd., of Manchester, and the National Gas Engine Company, Ltd., of Ashton-under-Lyne, who are among the most extensive manufacturers of gas-engines in Great Britain. The chapter on ignition is thorough and exceptionally clear, and covers its development from the method employed by Barnett in 1838 to the modern application of electricity. Apparatus and methods of speed regulation are also treated at length. A chapter is given to a description of the characteristics of various gaseous fuels, including, in addition to the various types of manufactured gases, petroleum, petrol, and paraffine base oils. The automobile motor, from the standpoint of European practice, is discussed exhaustively with regard to both operation and design. Descriptions are given of many typical European motors, including those most recently developed for aeroplanes. The chapter on carbureters is especially good and shows evidence of careful study of this part of the internal-combustion engine. Heavy oil engines, including those of the Diesel type, are discussed from the standpoint of design and operating results. This section should be of special interest in this country, as European practice is far in advance of that in the United States. The last chapter in the book is given over to marine-type gas and oil-engines. As a whole this book is distinctly good, although the types of engines and operating practice refer entirely to European conditions.

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Engineers' Note Book

Method of Computing Reinforced Concrete T-Beams*

By GUNDER HANSON

The following is a short method for computing reinforced concrete T-beams when the neutral axis is in the web. Neglecting the compressive stress in the web we have the following relation between x, y, d, and t:

$$x/d = k, \text{ and } t/d = \Delta$$

also $$x - y = t/2 - t^2/6\ (2x - t) \qquad (1)$$

dividing (1) by t we have

$$(x - y)\ t = \tfrac{1}{2} - t/6\ (2x - t) \qquad (2)$$

calling this expression c_1 and substituting for x its value in terms of k and d we have

$$c_1 = \tfrac{1}{2} - t/6\ (2kd - t)$$

which simplified becomes

$$c_1 = \tfrac{1}{2} - \Delta/12k - 6\Delta \qquad (3)$$

from which c_1 can be calculated when k and Δ are known.

Also from the diagram we have the relation that

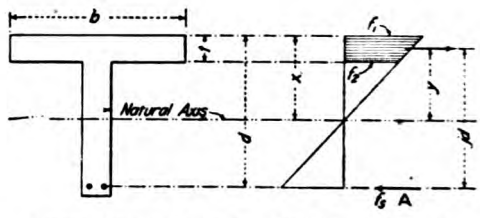

DIAGRAM OF T-BEAM CONCRETE SECTIONS.

$$f_1/x = f_2/(x - t) = (f_1 + f_2)/(2x - t)$$

from which we obtain:

$$(f_1 + f_2)/2 = f_1\ (2x - t)/2x \qquad (4)$$

Substituting this value in the moment equation:

$$M = b\ t\ j\ d\ (f_1 + f_2)/2$$

gives

$$M = f_1\ b\ t\ j\ d\ (2x - t)/2x \qquad (5)$$

or

$$f_1 = \frac{M}{b\ t\ j\ d} \cdot \frac{2x}{2x - t} \qquad (6)$$

Expressing $2x/(2x - t)$ in terms of k and d and calling the expression c_2, we have:

$$c_2 = 2\ k\ d/(2\ k\ d - t) = 2k/(2k - \Delta) \qquad (7)$$

Then $f_1 = M\ c_2/b\ t\ j\ d$ and c_2 can be cal-

TABLE 1.—VALUES OF C_1 AND C_2 FOR n = 12

Δ	Values of C_1, Percentage of Steel. 0.80	0.70	0.60	0.50	0.40	0.30	0.20	Values of C_2, Percentage of Steel 0.80	0.70	0.60	0.50	0.40	0.30	0.20
0.08	0.487	0.486	0.485	0.484	0.482	0.479	0.470	1.08	1.08	1.09	1.10	1.11	1 14	1.18
.09	.484	.483	.482	.480	.477	.473	.463	1.09	1.10	1.11	1.12	1.13	1 17	1 22
.10	.482	.481	.479	.477	.473	.467	.455	1.11	1.12	1.13	1.14	1.16	1.20	1.27
.11	.479	.477	.475	.472	.468	.460	.446	1.12	1.13	1.15	1.16	1.19	1.24	1.32
.12	.476	.474	.472	.468	.463	.454	.436	1.14	1.15	1.17	1.19	1.22	1.28	1.38
.13	.472	.469	.467	.463	.457	.447	.425	1.16	1.18	1.19	1.22	1.25	1 32	1.44
.14	.469	.466	.462	.458	.451	.439	.415	1.19	1.20	1.22	1.25	1.29	1.37	1 50
.15	.465	.462	.457	.452	.444	.430	.402	1.21	1.22	1.25	1.28	1.33	1.42	1.58
.16	.461	.458	.452	.447	.437	.421	.389	1.23	1.25	1.28	1.32	1.37	1.47	1.67
.17	.457	.453	.447	.440	.427	.411		1.26	1.28	1.31	1.36	1.42	1 53	
.18	.453	.448	.442	.434	.422	.401		1.29	1.31	1.35	1.40	1.47	1 59	
.19	.448	.442	.436	.427				1.31	1.34	1.38	1.43			
.20	.443	.437	.430	.420				1.34	1.38	1.42	1.47			
.21	.438	.431						1.37	1.41					
.22	.432	.425						1.41	1.45					

TABLE 2.—VALUES OF C_1 AND C FOR n = 15

Δ	Values of C_1, Percentage of Steel 0.80	0.70	0.60	0.50	0.40	0.30	0.20	Values of C, Percentage of Steel. 0.80	0.70	0.60	0.50	0.40	0 30	0.20
0.08	0.488	0.488	0.487	0.486	0.484	0.481	0.475	1.07	1.07	1.08	1.08	1.10	1 12	1.15
.09	.486	.486	.484	.483	.481	.477	.469	1.08	1.08	1.09	1.10	1.12	1 14	1.19
.10	.484	.483	.481	.480	.477	.472	.462	1.10	1.10	1.11	1 12	1.14	1 17	1.23
.11	.481	.480	.478	.477	.473	.467	.455	1.11	1.12	1.13	1.14	1.16	1.20	1.27
.12	.479	.477	.475	.473	.468	.461	.447	1.13	1.14	1.15	1.17	1.19	1 23	1.32
.13	.476	.474	.472	.469	.463	.455	.438	1.14	1.16	1.17	1.19	1.21	1.27	1.37
.14	.473	.471	.468	.464	.458	.448	.429	1.16	1.18	1.19	1.22	1.25	1.31	1.43
.15	.469	.468	.464	.460	.453	.441	.419	1.18	1.20	1.21	1.24	1.28	1.35	1.49
.16	.466	.464	.460	.455	.447	.433	.409	1.20	1.22	1.24	1.27	1.32	1.40	1.55
.17	.462	.460	.456	.450	.441	.425	.397	1.22	1.24	1.27	1.30	1.35	1.45	1.62
.18	.459	.455	.451	.444	.434	.417	.384	1.25	1.27	1.30	1.34	1.39	1 50	1 69
.19	.455	.451	.446	.438	.427	.409		1.27	1.29	1.33	1.37	1.43	1.55	
.20	.451	.446	.440	.432	.420	.400		1.30	1.32	1.36	1.41	1.48	1.60	
.21	.446	.441	.435	.426				1.32	1.35	1.39	1.45			
.22	.442	.436	.429	.419				1.35	1.38	1.43	1.49			
.23	.437	.431						1.38	1.41					
.24	.432	.425						1.41	1.45					

*Abstract from *Engineering Record*, January 25, 1913.

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culated when k and Δ are known.

To find k in terms of Δ, Turneaure and Maurer's formula is employed. This gives

$$k = \frac{(b\,t^2/2d) + n\,A}{b\,t + n\,A}$$

where A = area of steel.

Substituting $A = p\,b\,d/100$ where p = percentage of steel, we have

$$k = \frac{(b\,t^2/2d) + (n\,p\,b\,d/100)}{b\,t + (n\,p\,b\,d/100)}$$

which becomes

$$k = \frac{(\Delta/2) + (n\,p/100\,\Delta)}{1 + (n\,p/100\,\Delta)}$$

which can be evaluated for different values of n.

From these values the corresponding values of Δ can be readily obtained. Values of c_1 and c_2 can be found once for all and are given in the accompanying tables for $n = 12$ and $n = 15$. Finally we have $j\,d = d - c_1 t$; $f_s = M/j\,d\,A$; and $f_1 = M\,c_2/j\,d\,b\,t$.

Hints on Practice

Care of High Vacuum Apparatus

In plants carrying a high vacuum, a large supply of cold water is absolutely essential. This may be curtailed by mechanical troubles in the pump or its prime mover, too small pipes, dirty strainers, pipes, or tube-sheets, or by air leaks in the suction piping or at the shaft glands on the circulating pump. Leakage at the glands is a most prolific source of trouble which can be overcome by proper ways of packing, such as the following, which does not require frequent renewals:

Fill the stuffing-box for about one-third its depth with a soft metal packing, another third with a flanged metal ring, and the rest of the box with the same soft metal packing. Then screw the gland up fairly tight. Drill down through the casing into the box near the inner flange of the metal ring, and make a ¼-in. pipe connection to the discharge side of the pump. This forms an effective water seal that will fill any groove that may be cut in the packing, and prevent air from flowing in.

The wet-air pump should be set with its suction inlet slightly below the condensed-water outlet in the condenser, and a drain connection provided in the suction chamber, which should be opened when the air-pump is stopped. Cast-iron flanged pipe and fibre gaskets are satisfactory on the air-pump line, which should be as straight as possible and as large as the pump outlet. The hot-well line should have a controlling valve near the pump, and means for discarding contaminated condensate. If the piping be tight and the pump packing receives ordinary care, little trouble will arise. The water valves should be of composition to withstand the rise in temperature that will occur should the vacuum fail. Where there is more than one, the air-pumps should be interchangeable.

Dry-air pumps are generally of the rotative type, with water-jacketed air cylinders and metal valves. If the piping is tight they give little or no trouble, the attendance required being only that needed by any reciprocating engine of the size and speed.

The hot-well pump, usually situated about 4 ft. below the outlet of the condenser, is controlled by a float in a chamber at the base of the condenser, and adjusted to stop the pump while there is still a little water in the chamber. These pumps should be in duplicate to guard against failure.

Use of Thermometers.—As a small change in the vacuum on a turbine makes a comparatively large difference in the economy, engineers have ceased to depend upon the spring vacuum gauge as an indicator, and have turned to the more accurate mercury column, which in turn is checked by thermometers, for no change can occur in the degree of vacuum without a corresponding change in temperature. The connection of the mercury column gauge to the steam-inlet neck of the condenser is made as short as possible. Thermometer sockets are also placed in this neck, and in the circulating-water inlet and outlet, the rear head of the condenser, and the hot-well line. All thermometers should have a range at least up to 240°F. Another thermometer is hung in the room adjacent to the mercury column gauge, by which to correct the readings for temperature differences.

The accompanying table is a condenser log taken from a 200-kw. Curtis horizontal turbine unit, covering a period of about 5 hr. At 6:30 p.m. the load was extremely light, and the vacuum apparatus in normal condi-

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CONDENSER LOG

Condenser No. 3. Date: July 13, 1911.

Hour.	Vacuum.	Kw.	Temperature. Inlet water...	Outlet water...	Rear head....	Steam inlet...	Air-pump discharge	Hot-well line..	Remarks.
6:30 p.m.	28.4	900	72	82	73	90	89	89	
7:00 p.m.	28.0	900	72	88	75	98	97	97	Strainer partly clogged.
7:30 p.m.	28.4	1160	72	82	73	90	89	89	
8:00 p.m.	27.8	1960	72	96	77	101	100	100	Insufficient circulating water.
8:30 p.m.	28.3	2260	72	83	73	92	91	91	
9:00 p.m.	28.4	2030	72	78	72	90	89	89	Too much circulating water.
9:30 p.m.	27.9	1860	72	82	73	101	100	100	Leak at glands plunger rods of air pump.
10:00 p.m.	28.4	1860	72	82	73	92	90	90	
10:30 p.m.	28.4	1800	72	81	73	92	91	91	
11:00 p.m.	28.4	1800	72	82	73	92	91	91	

tion. At 7 o'clock the vacuum had dropped to 28 in. without any change in the load. The increase in the temperature of the discharge water indicated an insufficient supply of circulating water. Investigation showed that the strainer on the intake was partly clogged. This was evidently cleaned, for at 7:30 the apparatus was in normal condition despite an increase in the load. At 8 o'clock the vacuum had fallen to 27.8 in., and the thermometer again showed a deficient supply of circulating water. This was corrected by throttling at the circulating-water inlet until the thermometer indicated the normal 10° rise.

At 9:30 the vacuum had fallen to 27.9 in. The thermometers indicated that the circulating water was at normal temperature, hence the cause had to be an air leak. This was found at the glands on the air-pump plunger rods, and corrected. The log shows normal conditions throughout the balance of the run. The table serves to show what valuable aid the thermometers render to the operator.

If centrifugal pumps are used to supply the circulating water, means are necessary for priming them quickly. A separate pump for this service is generally provided, although any one of the wet-air pumps may be used if means exist to discard the water that may be picked up in the operation.

Air Leaks.—If the turbine-shaft glands are steam-sealed, a gauge should be mounted upon each packing case. The usual pressure maintained on these glands is 10-lb. gauge, and the steam just shows at the glands when the vacuum is normal. If any leaking occurs a greater pressure must be maintained to seal the gland effectively. If the glands are water-sealed, there should be a water meter on the line supplying the sealing water, or else an indicating valve should be used to control it. The normal amount of water for sealing purposes being known, or the normal opening of the valve, a leak may be observed by the increased amount required.

Air leaks in the balance piping show by a marked rise in the degree of vacuum between no-load and full-load conditions. These leaks may or may not show when running non-condensing.

Leaks at the automatic atmospheric exhaust valve may be found by laying a temporary wooden cover over the end of the atmospheric exhaust, connecting a manometer gauge to the pipe, and working up a vacuum upon the unit. This may be done while the unit is in operation. Another method used where exhaust heads are placed on the end of the pipe is to admit steam to the pipe on the atmospheric side of the valve, and when the pipe is thoroughly

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heated, as shown by steam appearing at the end of the pipe, the steam is throttled until it just shows at this point. A vacuum is worked up, and a leak at the valve will cause the small amount of steam to disappear entirely.

Leaks in the air-pump valves will show by the pump failing to maintain a vacuum within itself when the suction valve is closed. Air leaks in the condenser shell or in the piping may be found by the smoke test, or by testing with a candle flame.

Testing Water for Contamination.—When the circulating water is taken from a stream, be it salt or fresh, there is always danger of contaminating the condensate through leaky tubes or tube packing. This may be guarded against by taking half-hourly chemical tests of the condensate. The necessary outfit consists of a dozen clear-glass 2-dm. phials, a dark blue or brown 2-dm. phial, a 4-oz. dark-brown bottle, a medicine dropper, and a tray to hold them. If the circulating water is salt or brackish, the chemical used is nitrate of silver, which is prepared as follows:

Weigh out 50 gm. of the silver nitrate crystals and place in the 4-oz. bottle, cover about 1 in. with distilled water (condensed steam), and shake until the crystals are entirely dissolved. Then fill the bottle to the top with distilled water. Next fill the dark-brown 2-dm. bottle two-thirds with the solution, and put the medicine dropper in it. Cork the balance and stand it aside until needed.

For a test take a 1½-dm. sample of the condensate from a convenient tap in the hotwell line by filling one of the clear-glass 2-dm. phials three-fourths full. With the medicine dropper held well above the mouth of the bottle containing the sample, press three drops of the solution in it. If a minute quantity of salt is present the sample will take on a bluish-white cast, but if much is present the sample will turn milky white. With a solution of this strength any water showing a trace of salt should be discarded until the leaky tube can be found and replaced. Care must be taken not to allow the dropper to touch the sample being tested, for if salt is present the small amount that adheres to the dropper will spoil the balance of the solution in the dark-brown 2-dm. bottle.

If the circulating water is fresh, the method of procedure is the same, but the chemical to be used and the strength of the solution will depend upon the injurious ingredient in the water, and the percentage that may be admitted to the system without giving trouble. The nitrate of silver test may be used if the water contains chlorides, and litmus if acids or alkalies are present. Oxalate of ammonia will show organic matter.

Leaky Tubes.—Having ascertained that some tube leaks, the defect may be found in two ways. One is by flooding—that is, by closing the valve between the condenser and turbine, and admitting water at about 10 lb. pressure to the steam space of the condenser after the water-chamber heads have been removed. The water finds its way through the leak, and will be seen running out at the ends of the defective tubes. It is well while the heads are off to blow all the tubes with an air jet to remove any sediment that may have collected.

Ofter a tube will split, and the flooding process fail to indicate the leak, due to the pressure on the outside of the tube closing it sufficiently tight to prevent the water coming through. Then the condenser must be drained and the vacuum method applied by starting the air pump. The pressure of the atmosphere will force the split tube open, and it can be found with a candle flame or by blowing a cloud of smoke against the tube sheet. Sometimes split tubes are difficult to discover, and one end of the tubes may have to be blanketed by pasting wet newspapers over the tube sheet. This requires a little patience and skill to avoid tearing.

Before closing the condenser, all the ferrules should be gone over to see that they are tight. It will save the trouble of taking off the heads at some future time, only to find that the leak is at the packings.—*Power.*

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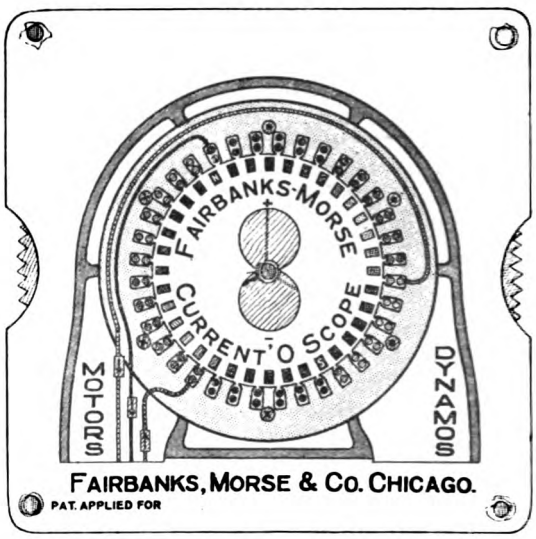
Industrial Progress

Revolving Field of Alternating Current Mechanically Illustrated



The Fairbanks-Morse Current'O Scope shows in a simple and correct manner how the so-called revolving field is produced by the action of alternating currents in a 3-phase alternating-current induction motor.

An alternating current is one whose direction of flow is reversed periodically so that it flows first in one direction for a brief period and then gradually decreases in strength, reaches zero, starts to flow in the opposite direction, and gradually increases in strength until it has the same value as before in the opposite direction, and then these processes are repeated. In a 60-cycle current, the reversals occur at the rate of 120 per second; in a 25-cycle current, they occur at the rate of 50 per second; two reversals for each cycle.

A 3-phase alternating current is really three alternating currents usually flowing in three wires, the reversals following each other in the three wires at equal intervals of time, always in the same order.

In the centre of the Current'O Scope there will be seen through the two circular openings three radial lines which represent the relative direction and flow of the electric current in phases 1, 2, and 3 of a 3-phase generator, or transmission line, or motor. For convenience, we will refer to them as black, green, and red currents in black, green, and red phases. When a line appears in the upper circle it indicates a current in the positive direction in that phase, and a line in the lower circle indicates a current in the negative direction. The length of the lines as they show through the circular holes indicates the strength of the current in amperes, which, it must be remembered, is constantly changing.

Turn the disc until the black line points vertically upward in the upper circle; this represents a current of maximum value flowing in the positive direction in the black phase.

Turn the disc left handed, or opposite to the motions of the hands of a clock, and notice that the black current decreases gradually, becomes zero, then reverses and starts in the negative direction, as shown by the appearance of the black line in the lower circle, gradually increases to its maximum negative value when the black line is vertical, decreases again to zero, changes to positive, and gradually increases until it reaches its maximum positive value again, when the black line is vertical. The red and green lines will be seen to pass through similar changes, following each other one-third of a revolution apart.

Again turn the disc until the black line points vertically upward in the upper circle; the black current is now at its maximum value in the positive direction, and the green and red currents are exactly half of the black current, in the negative direction. This may be looked upon as a current flowing inward through the black phase and dividing into two equal parts which return outward through the green and red phases.

Turn the disc in a direction opposite to the movement of the hands of a clock and note that the black current decreases, the green current increases, and the red current decreases. After moving the disc 30° it will be noticed that the decreasing black current and the increasing green current have reached the same value and the red current has disappeared. At this time there is no current in the red phase and all the current is flowing through the black phase and out through the green.

Turn the disc still farther in the same direction and the black current will go on decreasing while the green current increases, until after moving 30° the green line extends vertically downward, indicating that the green current has reached its maximum

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value in the negative direction, while the red current has reversed and is now flowing in the positive direction, as shown by the red line in the upper circle, and both the red and black positive currents are each equal to one-half of the green negative current. This condition may be looked upon as two equal currents flowing in through the red and black phases and joining together to flow out through the green phase.

Turn a little farther; the black and green currents decrease and the red current increases until after turning 30° more, the green negative current and the red positive current are equal and the black current has disappeared. Turn a little farther; the black current has reversed and is now flowing in the negative direction, and after moving 30° the red current has reached its maximum positive value and the black and green are both negative and each equal to one-half of the red.

Turning 30° more, it will be seen that the green current has disappeared, the black negative current is equal to the red positive current. Thirty degrees farther on, the black current has reached its maximum value in the negative direction, while the green and red are positive and equal to one-half of the black. This is exactly opposite to the condition with which we started when the black line was vertical.

Turning farther by steps of 30°, we observe the following changes in order: First, red current zero, black and green currents equal; second, green current maximum in the positive direction, red and black currents each equal to one-half the green in the negative direction; third, black current zero, red and green currents equal; four, maximum negative value of red current, black and green positive currents each equal to one-half of the red; fifth, green current zero, black and red currents equal; sixth, maximum positive value of black current, red and green negative currents each equal to one-half the black.

This brings us back to the same position with which we started, completes one cycle, and represents the changes which the three currents pass through sixty times a second in the case of a 60-cycle current.

If the disc is turned again watching one line at a time, it will be seen that each current in turn decreases from a positive maximum to zero and increases from zero to negative maximum, then decreases and passes through zero again and increases to a positive maximum.

The outer part of the diagram shows the frame, core, and windings of a 2-pole 3-phase induction motor; the pale green slotted ring represents the stator core, and the red, green, and black spots represent the wires in the stator slots; the red, green, and black lines running around the core from the left-hand foot of the motor indicate the lead wires through which the current flows to these windings, and the other ends of the three windings may be assumed to be all joined together at the back of the motor. In a 'star'-wound motor they actually are joined.

The arrows which appear through the slots in the motor foot indicate the direction of the currents in the lead wires, while the spots and crosses which appear through the round holes in the stator frame indicate the direction of the currents in the phase windings opposite which they appear, the crosses indicating a current flowing downward or away from the observer and the points indicating currents flowing upward or toward the observer. Where a zero appears in these holes, it indicates no current in that phase. The red and black shaded portions of the disc which show through the inner rectangular slots indicate the strength and direction of the magnetic field produced by the combination of the currents flowing in the different phases, the red indicating a north pole and the black a south pole. The deeper shaded portions where the letters N and S appear, indicate the points of maximum field strength, and the lighter shaded portions indicate the gradual weakening of the field on either of these points.

Placing the disc with the black line extending vertically upward through the opening at the centre of the diagram and looking at the arrows through the openings in the motor foot, we see that the black current is flowing inward to the upper part of the black phase windings and from there downward to the back of the motor where it passes through the end connections of the coils to the opposite windings of the black phase at the bottom of the diagram. After passing through all the windings of the black phase to the point where the 3-phase windings are joined together, it then splits into two equal currents which flow outward through the red and green phases, passing downward through that part of these wind-

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ings which lies above the horizontal line and upward through the parts lying below the horizontal line, as shown by the crosses and points back of the round openings.

In all the wires below a horizontal line through the centre of the diagram, the points that show through the openings in the stator core indicate that the current is coming upward toward the observer, and above a horizontal line, the crosses indicate that the current is going downward away from the observer. This is equivalent to right-hand rotation of the current about the central part of the left-hand inner surface of the stator core, and consequently produces a south pole at that point, while looking at the opposite or right-hand surface, the direction of rotation of the current would be left-hand and consequently a north pole would be produced at that point. The strength of the current in the black phase is at its maximum value and the strength of the current in the red and green windings is equal, therefore the total current strength above and below the horizontal line is the same, and the poles or points of maximum field strength are situated at the ends of the horizontal line.

Turning the disc in the left-hand direction until the next series of marks appear through the openings, we see that the currents are all in the same direction as before, but the green current has increased in strength a little and the red current has decreased in strength a little, so that the total current strength is no longer symmetrical about a horizontal line, but the green current in the windings above the line has strengthened and the red current has weakened, and below the line the red windings at the left have weakened while the green windings have strengthened, thus shifting the poles downward at the left and upward at the right.

Turning the disc another step, it will be seen that the current in the red phase has become very weak, while the green phase has gained still further in strength, thus shifting the poles still more. At the next step the red current has disappeared altogether and the black and green currents are equal, and it will be noticed that there are now two crosses in the two upper left-hand openings through the stator core and two points in the two lower left-hand openings, and as the current in the red and black phases is equal the poles are formed at the ends of a line 30° from the horizontal sloping upward to the right and passing through the centre of the red phase. The next step shows an increase of the current in the green winding and a decrease in the black current with a very small red current now in the positive direction, all tending to shift the north pole a little to the left of the 30° line. At the next step the green current has almost reached its maximum value and the poles are still farther shifted in the same direction, and at the next step the green maximum is reached and the poles will be found lying right upon the axis of the green winding and midway between the red and black.

It will be noted that whenever the current in one phase winding is at its maximum value, the currents in the other two phases coöperate with it to produce a magnetic flux along its axis, and when the currents in the two phases are equal with zero current in the third phase, it fluxes along the combined axis of the two current-carrying phases. At intermediate points the action of the current is such as to produce a great shifting of the flux from one axis to the other.

As the disc is farther turned step by step, it will be noticed that these changes are repeated and that the poles are shifted continuously in the same direction, until the black line is projecting vertically downward, showing that the black current has reached its maximum value in the negative direction, when the poles have made one-half of a revolution and the north pole is now at the left where the south pole was situated when we started, and upon turning the disc until the black line projects vertically upward again, completing one cycle for the current, it will be found that the poles have made one complete revolution; that is, for a 2-pole machine the revolving field makes one complete revolution for each cycle. For 4-pole machines there would be four poles about the circumference of the core instead of two, and the revolving field would advance from the initial position of one north pole to the initial position of another north pole or one-half of a revolution. For a six-pole machine, there would be one-third of a revolution for each cycle, and so on; the number of revolutions being equal to the number of cycles divided by one-half the number of poles. The number of revolutions is equal to 60 times the number of cycles divided by one-half the number of poles.

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Engineering News

Power, Gas, and Electricity

San Francisco.—The Board of Supervisors has granted permission to the City Electric Co. to extend its underground conduits in certain portions of Howard, Market, and Larkin streets; 1100 ft. of extensions are to be made in all.——The Railroad Commission reports the following: The Tulare County Power Co. has asked for permission to issue stock to the extent of $50,000 for line extension.——The Sacramento Natural Gas Co. has asked for authority to sell $200,000 of bonds for the purpose of liquidating existing indebtedness, constructing a new gas holder, extending pipe-lines, and drilling new wells.——The Petaluma & Santa Rosa Railroad has asked for authority to issue $80,000 in bonds and notes for $64,000 to provide funds for the construction of a trolley line from Liberty station to a new station to be called Two Rock, a distance of 5½ miles.——A decision has been rendered reducing the gas rate in the city of Palo Alto from $1.50 per thousand feet to $1.20.—The San Diego & Southeastern Railway has applied for permission to issue $500,000 in bonds to liquidate existing indebtedness.——The Livermore Water & Power Co. and W. A. Bissell have applied for authority to sell their plant to the Pacific Gas & Electric Co. at a price of $142,000.——The Pacific Gas & Electric Co. has asked for permission to apply part of the funds realized from the sale of the last issue of $5,000,000 in bonds to the enlargement of the Bear river canal. This is part of the Lake Spaulding power project. ——The United Light, Fuel & Power Co., operating in San Diego, Coronado, and vicinity, has asked for permission to issue capital stock to the extent of $100,000 for liquidating existing indebtedness incurred for construction work.

Oakland.—Gas and electric rates established for the coming year are as follows: For the first 10,000 cu. ft. of gas used, 90c. per thousand; from 10,000 to 20,000, 85c.; from 20,000 to 50,000 cu. ft., 80c.; over 50,000 cu. ft., 75c. The electric light rates were fixed as follows: For the first 100 kw-hr., 7c. per kilowatt-hour; 100 to 250 kw-hr., 6c.; 200 to 300, 5c.; 300 to 400, 4c.; and all over 400 kw-hr., 3 cents.

Oroville.—The Great Western Power Co. has announced that as soon as the Big Meadows dam has been completed, work will commence upon four additional power-plants at a cost of $8,000,000.

Redding.—The Northern California Power Co. will commence the construction of a new gas plant at a cost of $10,000.

Willows.—The Sierra Electric Power Co. has applied for a franchise for a pole line through Glenn county.

Marysville.—The Oro Electric Corporation has applied for a franchise for the operation of light and power lines.

Grimes, Colusa County.—The Oro Electric Corporation is preparing to build a steel-tower line from its power-house to San Francisco bay.

Los Angeles.—The Pacific Light & Power Corporation has completed plans for two power-houses at Big Creek, 80 miles east of Fresno, for the development of the first two units of its power system which will have a capacity of 75,000 hp. The ultimate development will be 300,000 hp. A transmission line 240 miles long will be built to Los Angeles. Water to the extent of 125,000 acre-feet is stored behind three dams, 160 ft., 90 ft., and 75 ft. high, respectively. The operating head for the first of the two units to be installed is 2100 ft., for the second unit 1900 ft. The transmission voltage will be 150,000. The Stone & Webster Engineering Corporation are the contractors for the entire work.

Riverside.—The Board of Public Utilities has approved a contract whereby the Southern Sierras Power Co. will move its general office from Los Angeles to Riverside. ——The bid of the Southern California Edison Co. for furnishing power at 85c. per kilowatt-hour has been accepted.

Spokane.—The Trustee Co., H. A. Flood, president, has applied for a franchise for installing and operating a central heating system to supply office building and business houses. The initial expenditure for the plant and mains will be about $200,000.

Wenatchee, Washington.—The Wenatchee Valley Gas & Electric Co. will install a gas plant at a cost of $100,000. Contract has been let for the installation of the plant to W. W. Hess of Philadelphia.——The Great Northern Railway will commence construction soon on the Chelan river power project. Between 80,000 and 100,000 hp. will be developed. The estimated cost of the

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work is $7,000,000. Robert Herzog is chief hydraulic and electrical engineer.

Oroville, Washington.—The hydro-electric power-plant at Similkameen Falls, four miles west of Oroville, is for sale. This plant was constructed at a cost said to be $125,000, and develops 450 horse-power.

Quincy, Washington.—The Wenatchee Valley Gas & Electric Co. has asked for a franchise for supplying electricity for power and lighting purposes.

Nelson, British Columbia.—The Waneta Development Co. will build a 2500-hp. hydro-electric power plant at the junction of the Salmon and Pend Oreille rivers near Waneta, at a cost of $75,000.

Denver, Colorado.—The Western Colorado Power Co. has been incorporated with a capital stock of $5,000,000 and will be a subsidiary of the Central Colorado Power Co. when the latter, now in the hands of receivers, is sold and reorganized. W. V. Hodges is the leading spirit in the new company.

Streets and Roads

San Francisco.—Property-owners have been granted permission by the Board of Public Works to have street work performed under private contracts as follows: 26th avenue, between Balboa and Cabrillo streets; Harrison, between 21st and 22nd streets; Balboa street, between 22nd and 23rd streets; Geneva avenue, between Tara and Louisberg streets; crossing of 39th avenue and Balboa street; Balboa street, between 38th and 39th avenues; crossing of Balboa street and Fortieth avenue; crossing of Thirtieth and Sanchez streets.

San Mateo.—A. B. Eddy and B. F. Burrell, consulting engineers, are to deliver a course of lectures in support of the $1,250,000 bond issue which is to come before the voters on April 8.

Sacramento.—$800,000 in California Highway bonds were sold on March 4.——The California State Highway Commission has awarded a contract to John D. Marsh for the construction of a road in Los Angeles county from Rancho El Encino to Calabasas at a price of $55,555.

Roseville.—An ordinance has been passed calling for a bond election on April 13, to provide $20,000 to build a section of highway 1.88 miles long through Roseville.

Venice.—The Beach Land Co. is expending approximately $12,000 on paving at Playa del Rey with hydraulic concrete. J. D. Marsh, of Los Angeles, is the contractor. The same company is expending about $4500 for grading Vista del Mar.

Redondo Beach.—A new pavement 50 ft. wide and 200 yd. long is to be constructed.

Manhattan Beach.—Paving of Second street from Manhattan avenue to Highland avenue; Highland avenue, from Second street to 37th street; 37th street from Highland avenue to the Strand; and the Strand to the northern city limits is under way. Wilkie Woodward is city engineer.

Los Angeles.—The following contracts for street and pavement work have been awarded:

Broadway (Wilmington), from First to Fourth. Awarded to B. C. Nichols at 18.5c. per sq. ft. for asphalt paving; 50c. per sq. ft. for granite block gutters; 35c. per lineal foot for cement curb; 12c. per sq. ft. for sidewalk; $4900 for storm drains; aggregate, $25,219.35.

Council street, from Rosemont to Burtz. Awarded to J. Hein at $7 per lineal foot for grading and graveling; 7c. per sq. ft. for regrading, grading, and oiling; 35c. per lineal foot for cement curb; 15c. per sq. ft. for concrete gutter; 35c. per sq. ft. for vitrified block gutter; 11c. per sq. ft. for sidewalk; aggregate, $3249.88.

Eighth avenue, from 21st to Washington. Awarded to John R. Ott Contracting Co. at $1.85 per lineal foot for grading and graveling; 32c. per lineal foot for cement curb; 15c. per sq. ft. for cement gutter; 33c. per sq. ft. vitrified block gutter; 12c. per sq. ft. for sidewalk; aggregate, $1331.70.

Fifth avenue, from Pico to north line of Country Club Terrace tract. Awarded to Barber Asphalt Paving Co. at 14c. per sq. ft. for asphalt paving; 31.9c. per sq. ft. for brick paving; 40c. per lineal foot for cement curb; 17.4c. per sq. ft. for cement gutter; 31.9c. per sq. ft. for vitrified block gutter; $276.50 for storm drain; aggregate, $6387.15.

Fourth avenue, from Pico to north line of Country Club Terrace tract. Awarded to the Barber Asphalt Paving Co. at 14c. per sq. ft. for asphalt paving; 31.9c. per sq. ft. for vitrified block gutter; 17.4c. per sq. ft. for cement gutter; 31.9c. per sq. ft. for vitrified brick gutter; $224 for storm drain; aggregate, $6064.95.

Hawthorne avenue, from 260 ft. east of Formosa to 225 ft. west of Formosa. Award-

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CALIFORNIA State Highway in Los Angeles County Division VII Route 2. Section B. Awarded March 4 13 to

Items	Quantities	Estimate	J CONSIDINE	L G GARNSEY	ROGER BRO. CO.	JM MONTGOMERY	G BENSON & SON	BENT & PENNE	John D MARSH
	cubic yards	Per unit	of Los Angeles	of Los Angeles	of Los Angeles	of Alhambra	of Los Angeles	BAKER of LA	of Los Angeles
Excavation (without classification)	19400	.40	.45	.56	.50	.80	.45	.45	.50
12" Corru-	240 lin.ft.	1.05	1.15	1.60	1.50	1.20	2.00	1.40	1.40
18" gated	244 "	1.50	1.55	2.00	1.75	1.45	2.25	2.00	1.60
24" Iron	148 "	1.90	1.95	2.50	2.80	2.03	2.75	2.50	1.90
30" Pipe	26 "	2.65	3.00	3.45	3.00	2.82	3.50	3.75	2.30
36" "	52 "	3.20	3.50	4.00	4.00	3.80	4.00	4.50	2.60
Class (culverts masonry)	60 cu.yd.	10.00	8.00	10.00	9.00	9.00	12.00	15.00	9.50
Bcanc (paving	9900 - "	4.00	4.60	4.50	4.39	4.10	4.95	7.00	4.00
Heating, placing Asphaltic Oil	800 bbls	1.30	2.00	1.50	2.00	1.50	3.00	2.00	.80
Bro. stone screen	1260 tons	1.70	1.75	2.56	2.25	2.27	3.00	2.25	2.40
Guard rail (ings	2350 lin.ft.	.35	.40	.38	.50	.40	.60	.25	.30
Roal - ent Monuments	127 each	.60	4.00	1.00	5.00	1.00	4.00	2.00	.90
TOTAL BID			$61151.48	$61205 80	$62999 30	$61389 00	$62990 36	$68288 00	$85732 00	$55555.90

State Highway in Mendocino County Division I Route 1 Section C

Items	Quantities	Estimate	EB & AL STONE	FAIRBANKS & BA	DL SAWYER &	RAISCH IMPROV			
Excavation With-	cubic yards		CO of S.F.	CRIEL-WILLITS	C WHITE-WILLITS	CO of SAN F.			
out classification	24200 "	45	50	.65	.66	1.00			
12" Corrugated	454 lin ft	2.00	2.00	2.00	1.56	3.50	Bids	Opened	Feb 28 13
18" Iron	50 " "	2.25	3.00	2.25	1.92	4.50			
24" Pipe	102 " "	2.50	3.50	2.50	2.61	6.00	CALIFORNIA		
RCpe Monuments and culverts	194 cu yd	9.00	20.00	20.00	11.00	14.00			
Broken stone	11000 tons	2.25	2.75	2.90	2.10	3.50	HIGHWAY COMMISSION		
Gravel	7450 cu yd	1.25	1.50	1.75	1.31	3.15			
Guard rail	800 lin. ft	.25	.50	.25	.33	.30	Dept. of Engineering		
Paving, repairing Property fences	3 miles	150.00	500.	333.33	250.00	150.00			
Heating & setting Monuments	120 each	1.00	1.00	1.00	2.20	2.50	Sacramento		
TOTAL of BID		$56055.60	$60840.00	$61,143.00	$53313.96	$92299.50			March WE

ed to O. A. Nichols at 12.4c. per sq. ft. for sidewalk; aggregate, $337.53.

Serrano avenue, from Melrose to Torrence. Awarded to John R. Ott. Contracting Co. at $1.18 per lineal foot for grading and graveling; 32c. per lineal foot for cement curb; 14.5c. per sq. ft. for cement gutter; 35c. per sq. ft. for vitrified block gutter; 12c. per sq. ft. for sidewalk; aggregate, $2923.94.

Vermont avenue, from Sixth to Washington. Awarded to Fairchild-Gilmore-Wilton company at 17c. per sq. ft. for asphalt paving; 30c. per sq. ft. for brick paving; 35c. per lineal foot for cement curb; 30c. per sq. ft. for vitrified block gutter; 45c. per sq. ft. for granite block gutter; 10c. per sq. ft. for sidewalk; $450 for culverts; $3500 for storm drains; $265 for catch basins; aggregate, $44,387.22.

Contract for 6000 ft. of redwood planking has been let to S. C. Larsen at 4½c. per foot. This is to be used for borders for walks.

Spokane, Washington.—Plans are being prepared at the office of J. W. Strack, county engineer, for the Market street paving extension. Morton Macartney, city engineer, has announced the following contracts:

Ninth and Tenth and Rockwood avenue from Grand boulevard to Hatch street; asphalt pavement to be laid by the Inland Empire Hassam company.

Boone avenue from Division to Superior street; only the catch basins have been installed; bitu-mass pavement to be laid by the Bitu-Mass Paving Company.

Seventh avenue from Howard to Monroe street; to be paved with bitu-mass.

Other work which is being done by a contractor is the Hangman creek bridge. Nearly $200,000 in construction work is yet to be done on it.

The Inland-Empire Hassam Paving Co. has submitted to the city a specification for Hassamite laid on a 5-in. concrete base, bitumen laid on the concrete 5 in. thick, and also on bituminous concrete.——Plans are being prepared by the city engineer for paving Mission avenue from Division street to the Mission avenue bridge.

Pomeroy, Washington.—A proposal has been accepted that the Government furnish part of the funds and the county the balance to build 12 miles of road No. 16 in 1913.

Davenport.—County commissioners will use 20 steel drags for repairing dirt roads. The cost has been found to be $5 per mile. J. L. Thayer is county engineer.

Wenatchee, Washington.—The Cascade Scenic Highway is announced to have been financed, and will be completed within two years.

Lewiston, Idaho.—The county commissioners have awarded a contract to A. Larsen for the Central Ferry road and who has

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agreed to handle earth at 20c. per yard, gravel and loose rock for 35c., and solid rock for $2.75.——Mr. Wrighter, city engineer, has been instructed to prepare estimates of cost for grading, curbing, and laying cement sidewalks in the new district on Normal hill.

Walla Walla, Washington.—The city commissioners have ordered the paving of Division street.

Davenport, Washington.—Bids for macadamizing and regrading seven miles of the Harrington-Davenport road, beginning at Harrington and extending north, were opened by the commissioners, but they will not award the contract until the legislature appropriates the permanent highway money. Four Spokane contractors bid, and their prices, based on 12-ft. macadam, were: Spokane Asphalt, Macadam & Paving Co., $34,000; John T. Costella & Co., $35,700; A. S. Empey & Co., $37,000; Mitchell Bros., $37,200.

Washtucna, Washington.—The city council has decided to grade and gravel Main street from School to Canal street. They have also ordered the grading of the hill which leads from the O. W. R. & N. tracks east of the S. P. & S. depot.

Seattle.—The demonstration highway at Olympia is under way. The Dolarway Paving Co. and the Western Association of Portland Cement Manufacturers have let contracts, and excavations have been completed.

Carson, Nevada.—Two bills providing for the building of a state highway have been passed by the Nevada Legislature. One provides for a direct line across the state from a point in Elko county to Reno, and thence to Carson and Lake Tahoe; the other from Cobre, Ely, and White Pine county points to Reno and thence to Carson and Lake Tahoe.

Ogden, Utah.—A new grade has been recommended for Wall avenue by H. J. Craven, city engineer.

Boise, Idaho.—The Governor has signed a bill creating a $10,000 bond issue to provide funds for the construction of a state highway from Boise to Yellowstone Park. He has also signed the bill creating a $200,000 bond issue for the formation of a state highway commission and providing funds for the construction of a uniform highway system throughout the state.

Salt Lake City, Utah.—The general road bill introduced in the state legislature provides $97,200 annually for road building and $50,000 for the construction of the Midland trail, and $5000 for the Pioneer trail.

Irrigation and Water Supply

San Francisco.—The California Railroad Commission has instituted an investigation of the rates and practices of the East Side Canal & Irrigation Co., which operates in Merced county. Complaints have been made that the service was inadequate and that the rates were high.——A request has been made for an 8-in. pipe-line from the Spring Valley main at Tenth avenue and K street to the Sunset district. A pumping plant will also have to be built.——The Natomas Consolidated has developed artesian water at a depth of 708 ft. on the Johnson property near Riego.

Martinez.—Balfour-Guthrie Investment Co. of San Francisco has applied to the Contra Costa Board of Supervisors for permission to construct a 7-mile canal from Indian slough to Brentwood. The canal will be 30 ft. wide and will require three concrete bridges and concrete siphons across the county roads and under the railroad crossings.

Chico.—John R. Robinson has been made president and general manager of the Chico Water & Supply Co. Foundations have been laid for a steel tank of 150,000-gal. capacity.

Oroville.—J. M. Martin, Jr., of San Francisco, has appropriated 3000 miner's inches of water to be taken from the Feather river near Central House for irrigation purposes.

Los Angeles.—Theodore B. Comstock, consulting engineer, has completed plans for a water-supply system to be constructed for the California Farm & Home Builders at Fallbrook. Two cement reservoirs will be built and pipe-lines will be installed.

Portland.—John H. Lewis, state engineer of Oregon, has been in conference with F. H. Newell, Director of the U. S. Reclamation Service at Washington, D. C., regarding the survey of the Celilo Falls power and irrigation project. The state legislature has appropriated $15,000 for this work, and it is expected that the Federal Government will appropriate a like sum.

Ritzville, Washington.—The Keystone

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Water Users' Association has completed organization and elected trustees as follows: H. W. Goff, J. J. Kanzler, Fred Busher, R. I. Stone, and Arthur Funk. The company plans to take water from Sprague lake, 18 miles northeast of here, and for the first unit to irrigate 10,000 acres of land which lie between here and the lake.

Omak, Washington.—At a special election on February 28, $8600 was voted to provide funds for the design and construction of a new water system.

Ogden, Utah.—The Utah Light & Railway Co. will build a storage reservoir at this point. S. T. Whitaker is manager.

Billings, Montana.—An election is to be held in the latter part of March for the purpose of voting upon a bond issue for $575,000 to provide funds for the construction of a municipal water-supply system.

Railways

San Francisco.—The Central Pacific Railway Co. has applied to the Railroad Commission for authority to extend its Melrose-San Leandro line and its line across Fruitvale avenue, Bassett street, and Brandon street.——The contract for constructing the roadbed for the Geary street municipal railway from the west side of Kearny street along Market street to Sutter street, has been awarded to F. Rolandi for $21,900.——The Union Iron Works has been granted an extension of 60 days' time in which to complete 23 cars for the municipal railway.

Sacramento.—The Northern California Railroad & Navigation Co. has filed articles of incorporation. The capital stock is $1,100,000. The directors are George W. Bartle, Oscar W. Bartle, J. D. Rhoades, Swin Swinson, Rob B. Howarth, and F. C. Messick.——The State Railroad Commission has granted authority to the California, Shasta & Eastern Railway Co. to issue bonds in the sum of $568,000, and stock to the amount of $349,500. This company has been organized to operate between Anderson, Shasta county, and Ingot, a distance of 28½ miles. The Shasta & Eastern Railway Co. will take over the Anderson and Bella Vista railroad and extend it 12 miles to Ingot.

Los Angeles.—Franklin D. Howell, engineer for the Municipal Railroad Committee, has completed plans for the construction of a belt line municipal railroad to San Pedro harbor.

Newport, Washington.—The Fidelity Lumber Co. will construct a logging railway from the mouth of Skookum creek to its timber holdings.

Logan, Utah.—Work on the extension of the lines of the Logan Rapid Transit Co. from this city to Ogden is to commence at once.

Ogden, Utah.—The Ogden, Logan & Northern Electric Railroad Co., of which P. M. Wells of Omaha is in charge, has completed preliminary surveys of its proposed line from Preston, Idaho, to Liberty, Utah.

Miscellaneous Engineering Construction

San Francisco.—The West Coast Iron Co. is constructing a plant at 16th and Rhode Island streets to reduce iron ore by means of oil fuel. Horace W. Lash is president of the company and inventor of the process.——Instructions have been given by the engineers of the Santa Fé Railroad to prepare drawings and specifications for a bridge to be erected across Islais creek.——The Board of Works has stated that plans, estimates, and specifications for the Twin Peaks tunnel will be completed by April 1.——The Board of Public Works will receive bids on April 9 for the Stockton street tunnel, and on April 19 for the completion of contract No. 37 for sewers and appurtenances in Golden Gate Park and 48th avenue.——An extension of time has been granted to the contractors who are building the Islais creek incinerator on account of changes of plans by the City Engineer.——The following sewer work has been ordered by the Board of Public Works: crossing at 24th avenue and Balboa street; in Balboa street between 34th and 35th avenues, and between 35th and 36th avenues; crossing at 36th, 37th, 38th, 39th, and Balboa streets; in Balboa street between 37th and 38th avenues and between 38th and 39th avenues, and crossing in Balboa street and 40th avenue.——A steam pump and storage tank are to be installed in the municipal railroad car barn; $2000 has been appropriated for this purpose.——The U. S. Navy Department has placed an order with the Mare Island Navy Yard for the construction of the new oil fuel ship *Maumee*. Crude-oil engines will be used. The cost of the vessel complete will be about $1,400,000.——A

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ferryboat to cost $300,000 is under construction for the Western Pacific Railroad at the yards of the Moore & Scott Iron Works. The vessel will be 230 ft. long, 63 ft. beam, and will draw 11½ ft. of water.

Sacramento.—A bill has been introduced in the State Legislature appropriating $12,500 for the improvement of Mokelumne river. Mr. Givan, city engineer, has made a report to the city commission recommending the construction of a municipal ice plant at a cost of $50,000.

Willows.—The Glenn county supervisors have adopted plans for a Luten patent bridge to be erected across Stony creek near Orland. It will be of reinforced concrete construction and cost $145,000.

Suisun.—The Solano Irrigated Farm Co. has commenced construction of a new city situated midway between Suisun, Elmira, and Dixon on the line of the Oakland & Antioch Railway.

Redding.—The board of city trustees has decided to call for a bond election to provide $60,000 for the purpose of building a bridge over the Sacramento river.

Woodland.—A project is under discussion to call for a bond election to provide $50,000 to furnish funds for the construction of sewers, water mains, street improvements, and a septic tank.

Auburn.—Mr. Warner, city engineer, has reported upon a new sewer system for this city. A bond election will be called in April to provide funds.

Los Angeles.—The Board of Public Works has ordered the installation of ornamental electric light poles on Sixth street from Alameda to Hill street; Eighth street, between Main and Figueroa street, and Ninth street from Main to Figueroa.——The following bond issues are to be voted upon April 15: Electrical distributing system, $6,500,000; Los Angeles city aqueduct trunk line, $1,500,000; Chatsworth, Mission, Fernando, and Glendale aqueduct line, $2,000,000; Pasadena, Glendora, and San Dimas aqueduct high line, $2,500,000; harbor improvement, $2,500,000; new city hall, $1,000,000; municipal railroad, $1,000,000; purchase of normal school site, $600,000; total of all proposed issues, $17,600,000.——The city council has decided to go ahead with the construction of the Western avenue storm drain; estimated cost is $13,000.——Spur tracks are to be constructed on the Huntington concession at San Pedro harbor.——Bids will be opened on March 28 for dredging 1,300,000 cu. yd. of material from the Mormon Island channel and Wilmington basin.

Venice.—A. Stutzer has secured the contract from the Beach Land Co. for the bridge across the slough at Playa del Rey at a cost of about $2500. The bridge will be constructed of reinforced concrete piles, wooden caps and stringers. It will be 118 ft. long and 20 ft. wide. A total of $6000 will be expended by this company upon a new wharf.

Dinuba.—A contract has been let to Hall & Hunt for a new outfall sewer system at a price of $32,468.32.

Portland.—The director of the reclamation district has awarded a contract to the Standard Portland Cement Co. of San Francisco for furnishing 30,000 bbl. of portland cement for use on the Klamath-Umatilla, Okanogan, Yakima, and Orland projects. Contract price is $1.40 per barrel f.o.b. cars at Napa Junction, California.

Spokane.—A contract has been awarded to the Inland Portland Cement Co. of Spokane by the Chicago, Milwaukee & St. Paul Railroad for 30,000 bbl. of portland cement, making a total placed with this company of 90,000 bbl.——The Canadian Pacific Railway Co. has awarded the following contracts, aggregating $3,330,000, to Spokane contractors: Burns & Jordan, for 60 miles on the final 80-mile stretch of the Jukeson to Golden cut-off, in the Kootenai valley district, the work to cost approximately $2,500,000. The other 20-mile contract went to Boomer & Hughes, also of Spokane, for about $830,000. Burns & Jordan will start work on the new contract immediately, will employ about 2000 men, and will keep five or six steam-shovels at work. This work is on the Kootenai Central line of the C. P. R. The Burns & Jordan company was recently awarded a contract for $1,500,000 for the final 40-mile connecting link of the Grand Trunk Pacific and will start that work as soon as spring opens. The contract awarded to Boomer & Hughes is for 20 miles of work on the Jukenson to Golden line.

North Yakima.—H. J. Hanford, consulting engineer of Seattle, has been checking plans drawn by N. A. Gilman, city engineer, for the proposed $260,000 sewer system. The plans have been accepted by the city com-

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mission, and a bond election will be held to provide funds.

Wenatchee, Washington.—The drawbridge which connects Tacoma with the tide-flats near the municipal dock is to be removed and may be purchased by Chelan county. Fred A. Warren is county engineer.

Salt Lake City.—The county commissioners have decided to build four bridges at a cost of $5000, and culverts at a cost of $1500. Willard Snow is road supervisor. ——The county commissioners have authorized the purchase of corrugated iron culverts at a cost of $3000. This type of culvert has been adopted exclusively instead of wood.

Lewiston, Idaho.—The Camas Prairie Railroad will cement the roof of tunnel No. 7. Mr. Finch is superintendent.

Petroleum

The following table showing the world's total production is taken from the *London Petroleum Review*:

	1912.	1911.
United States	220,000,000	220,400,000
Russia	63,000,000	62,000,000
Rumania	12,500,000	10,800,000
Galicia	8,000,000	9,000,000
Dutch India	13,000,000	11,600,000
British India	7,500,000	7,200,000
Mexico	16,000,000	9,500,000
Other countries	10,000,000	7,000,000
Totals	350,000,000	337,000,000

California oil dividends for February were as follows:

Amalgamated	$1.00	$ 50,000.00
American Pet. pfd	0.005	8,255.50
do common	0.001⅓	39,607.00
Caribou	0.01	8,070.30
Central	0.0075	7,500.00
Claremont	0.01	4,500.00
Home (Coalinga)	0.01	10,000.00
*Monte Cristo	.....	.....
Mount Diablo	0.0075	7,500.00
Pacific Crude	0.01	7,000.00
Paraffine	0.01	3,000.00
San Francisco-McK	0.10	5,000.00
Sauer Dough	0.015	2,992.50
Section 25	0.50	20,000.00
State Consolidated	0.01	5,000.00
Traders	0.006	9,000.00
Union	0.006	184,753.60
Union Provident	0.006	91,403.02
Union Petroleum	0.006	48,450.60
Western Union (Spec.)	1.50	15,000.00
West Coast pfd	1.00	10,408.00
Western Union	0.50	5,000.00
Total		$542,440.52

*Dividend passed.

Production statistics for California fields for February were as follows:

San Joaquin Valley:	Net Feb.	Daily Av.
Coalinga	1,410,730	50,383.93
Kern River	748,856	26,744.85
Maricopa	390,292	13,939.00
Midway	2,170,558	77,519.93
McKittrick	336,995	12,035.53
Belridge-Lost Hills	325,643	11,630.10
Total	5,391,895	
Coast-South:		
*Santa Maria	347,583	15,985.11
Olinda-Brea-Puente	491,738	17,562.07
Salt Lake-Sherman	191,077	6,824.18
Whittier	54,896	1,960.57
Coyotes-La Habra	217,848	7,780.28
Ventura County	65,140	2,326.43
Newhall	8,512	304.00
Los Angeles City	28,500	1,017.86
Summerland	4,000	142.85
Total	1,409,294	
Grand total for state	6,801,189	242,899.61
Shipments	6,426,080	228,074.28
Losses	90,959	2,248.53
Total outgo	6,517,039	
Surplus	271,977	9,713.00

*Santa Maria, Lompoc, Cat Canyon.

(In January McKittrick and Belridge were grouped, and in February Belridge and Lost Hills. The daily increase given is for the three fields combined.)

Exports for February include machinery for oil production shipped to Japan and valued at $36,377. The list in detail follows:

	Gallons.	Value.
Crude	2,667,000	$ 51,850
Illuminating	5,047,237	244,097
Distillates	11,201	1,519
Lubricating	84,236	18,520
Gasoline	33,970	6,167
Fuel oil	8,151,591	136,079
Asphalt(mfg.)	5,012	51,933
Oil well supplies:		
Colombia		$ 655
Japan		36,377

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Field conditions and development for February were:

	New rigs.	Wells Drilling. Active.	Idle.	Month's Completions. No.	Output.	Producers. Active.	Idle.
Coalinga	6	61	59	5	810	876	202
Kern	..	9	4	4	50	1653	229
Maricopa	2	35	56	2	4,125	284	112
Midway	15	107	84	18	7,585	707	246
McKittrick	2	4	21	1	100	239	35
Belridge	3	10	21	5	950	61	3
Lost Hills	8	16	33	8	815	59	1
Santa Maria	..	16	42	1	.....	271	17
Olinda-Brea-Puente	3	27	3	..	.....	330	15
Salt Lake	4	10	2	1	150	290	13
Whittier	1	6	4	2	200	142	12
Coyotes-La Habra	2	28	2	3	2,500	18	1
Ventura	1	29	29	3	275	316	23
Newhall	..	3	2	..	.....	79	4
Los Angeles	..	...	..	..	.....	412	...
Summerland	..	...	..	..	.....	125	25
Total	47	361	362	53	17,860	5862	941

Stocks on hand at the end of February were:

	Field stocks.	Pipe-line.	Total.
Coalinga	501,952	2,558,145	3,060,097
Kern River	425,940	29,620,058	30,045,998
Maricopa	268,467	366,917	635,384
Midway	467,200	1,772,756	2,239,956
McKittrick	92,400	928,445	1,020,845
Belridge-Lost Hills	37,300	297,150	334,450
Santa Maria, Lompoc, Cat Canyon	315,629	470,288	785,917
Olinda-Brea-Puente	37,222	182,463	219,685
Salt Lake	101,166	132,216	233,382
Whittier	51,406	.....	51,406
Coyotes-La Habra	40,341	.....	40,341
Ventura	17,092	55,835	72,927
Newhall	2,443	.....	2,443
Los Angeles District	15,000	297,160	312,160
Outside	.....	8,913,503	8,913,503
Total	2,373,558	45,594,936	47,968,494

Martinez.—Part of the equipment, including agitators and condensers for the new Associated Oil Co.'s refinery at Avon, has been shipped. Contracts for machinery amount to $104,500.——Contracts have been awarded to the Western Pipe & Steel Co., of San Francisco, for 25 steel oil-tanks of 55,000 bbl. capacity for the Associated Oil Company.

Emeryville.—The American Gasoline Co. has secured a site at Emeryville for the erection of storage tanks.

Bakersfield.—A large number of operating companies are adopting electricity for pumping wells in the Midway district. More than 25% of the rigs are equipped with motors. The General Petroleum Co., the Indian & Colonial Development Co., the Traffic Oil Co., the M. H. & M. Oil Co., the Dome Oil Co., the Olig Crude Oil Co., the Traders', and the Santa Fe are substituting motors for other means of supplying power. It has been stated that in one case 87 wells were pumped for a month and produced 244,797 bbl. and consumed 207,255 kilowatt-hours.

El Segundo.—The three first asphalt stills of the Standard Oil Co.'s plant have commenced operation. The barrel-house and the loading-rack are completed. Two additional 1200-bbl. asphalt stills are being built.

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Panama-Pacific Exposition

Contract has been awarded to the Pacific Gas & Electric Co. for supplying electricity for light and power, gas for illumination, and steam for heating. The electrical requirements call for a minimum of 12,000 hp. during construction and 20,000 hp. after the Exposition opens. A generating station, including steam turbo-generators, will be constructed on the ground as an auxiliary. The steam contract calls for 30,000 lb. of steam per hour from 10 a.m. to 5 p.m.——The Building and Grounds Committee has let a contract for the high-pressure system for the Exposition to the Turner company. The contract is for $150,225.——Dredges, steam-shovels, 300 teams, and 1000 workmen are engaged upon the Exposition grounds. The yacht harbor is being dredged, construction work on the Machinery building is well under way, and 3,000,000 ft. of lumber has been unloaded upon the ground. Foundations have been completed.——It is stated that by the end of July, contracts for all of the 14 large exhibition palaces will have been awarded.——Plans have been approved for the Auditorium to be erected in the Civic Centre, at a cost of $1,000,000.——Bids have been called for the construction of the Pure Foods building. It will contain nearly 300,000 sq. ft. of floor space and will occupy a ground space of 400 by 550 feet.

Personal

GEORGE WATKIN EVANS, of Seattle, has returned from Vancouver, British Columbia.

B. K. STROUD, of the Universal Oil Co. at Wasco, was a recent visitor in San Francisco.

L. A. NICHOLSON, of Tacoma, is preparing plans for street improvements in Ruston, Washington.

H. B. GUTHRIE has been making tests of water found in the West Side oil fields in Kern county.

D. C. JACKLING, of Salt Lake City, has been elected president of the Utah Power & Light Company.

JOHN S. MARTIN, president of the Pacific Cement Gun Co. of San Francisco, has returned from San Diego.

W. J. RANKIN, Jr., of Seattle, attended the convention of the Idaho Society of Engineers at Weiser, Idaho.

C. A. PERKINS, of Seattle, manager of the Pittsburg Testing Laboratories, has returned from a trip to California.

J. A. TAFF, geologist for the Southern Pacific Co., has been giving expert testimony on the Elk Hills oil land suit.

SYLVESTER Q. CANNON is to be appointed city engineer of Salt Lake City to succeed D. H. BLOSSOM, who has resigned.

E. T. DUMBLE, chief geologist for the Southern Pacific Co., testified as expert witness in the Elk Hills oil land suit.

F. H. GALE, of the General Electric Co., Schenectady, New York, has been making an extensive tour throughout the western states.

A. D. BUTLER, assistant city engineer of Spokane, Washington, has been conducting a series of tests of the water of Spokane river.

H. B. WRIGHT, consulting engineer, delivered a lecture recently on road building before the Chamber of Commerce at Moscow, Idaho.

H. L. BOWLBY, former Highway Commissioner of Washington, has been appointed engineer for the Pacific Highway Association of Seattle.

L. C. STILES, county engineer of Willows, California, has been inspecting the proposed changes in route of the state highway through Glenn county.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, has been in Washington, D. C., on matters connected with the Hetch-Hetchy water-supply project.

LORAN E. HUNT, assistant city engineer, delivered a lecture before the New Era Club of San Francisco on the construction of the Geary street municipal railroad.

L. H. RODEBAUGH, traffic manager of the Central California Traction Co., has resigned to take a similar position with the Oakland, Antioch & Eastern Railway.

A. L. TROWBRIDGE, field engineer for the Pacific Gas & Electric Co., is investigating possibilities of supplying water for irrigation in the district near Grass Valley.

F. O. SHUTTS, assistant city engineer of San Francisco, was severely injured by being struck on the head with a plank at pumping station No. 2 near Fort Mason.

F. H. HOOVER, industrial agent for the Southern Pacific Co., has resigned to become connected with the Columbus Electric Railway & Light Co., at Columbus, Ohio.

J. B. FISKEN was elected president, J. W.

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HUNGATE vice-president, H. B. PIERCE secretary and treasurer of the Spokane section of the American Institute of Electrical Engineers.

WALTER H. KELLEY, assistant bridge engineer for the Oregon Short Line at Pocatello, has resigned his position to take charge of construction of the new dam for the Great Falls Development Company.

Catalogues Received

H. N. BYLLESBY & Co., engineers, of Chicago and New York, have issued a very attractive folder describing the operation of their department of examinations and reports.

THE SNOW STEAM PUMP WORKS, Buffalo, New York. Bulletin S-110, 'The Snow Crude Oil Engine,' describing the operation and construction of the Snow crude-oil engine of the Diesel type, manufactured in single units from 50 to 600 horse-power.

CALIFORNIA CORRUGATED CULVERT CO., West Berkeley, California. 'Highway Improvements News,' devoted to highway construction in general and particularly to the application of the corrugated iron culverts manufactured by this company.

O. F. JORDAN CO., Chicago, Illinois. Catalogue illustrating and describing the Jordan spreader with pneumatic control, a machine used to spread and level material and which has been equally successful as a snow-plow, grade making, and ballast spreading.

CONNECTICUT MANUFACTURING CO., New London. 'The Connecticut Turbine,' advance sheet from catalogue illustrating and describing the steam turbines manufactured in sizes from 25 to 500 hp. by this company. Catalogue in full will be sent on request.

C. W. HUNT CO., West New Brighton, New York. Catalogue No. 12-9 describes the Hunt noiseless gravity bucket conveyor for handling coal, ashes, phosphate rock, cement, etc.; full details regarding construction and operation are given and accessory apparatus is also illustrated and described together with typical general arrangements to complete plants.

SOUTHERN CALIFORNIA EDISON CO., room 114, Edison Bdg., Los Angeles, California. 'Edison Current Topics,' for December 1912, contains a number of interesting articles of technical interest, including one on artificial respiration in electric shock, by Dr. Herbert C. Stinchfield. The following issue contains a continuation of Dr. Stinchfield's paper and a paper on classification of accounts for electric corporations, by Byron T. Story.

Commercial Paragraphs

The BUREAU OF FOREIGN AND DOMESTIC COMMERCE, Washington, D. C., will issue a series of consular reports on the market for American-made machine-tools in Latin America. A monograph dealing with the manufacture of electrical instruments and meters in Europe will also be issued.

EVANS-DICKSON CO., of Tacoma, has issued a pamphlet describing the electrical work for the Nisqually power-plant which it has recently completed. This company is also constructing a transmission line, street-lighting system, and pump-house for the U. S. Government at Fort Casey, Washington.

The FRANKLIN ENGINEERING CO., Hoge building, Seattle, Washington, has received the contract for the concrete work for an 1100-ft. bridge for the Great Northern Railway across Salmon Bay waterways. The bridge will be of the Strauss Trunnion Bascule type for which Gerrich & Gerrich of Seattle are the general contractors. The Franklin company is completing a reinforced concrete match factory for the Pacific Coast Match Company.

The NEW LONDON SHIP & ENGINE CO., of Groton, Connecticut, announces the installation of the first horizontal Diesel engine in the United States. The engine is a 4-cycle, 2-cylinder, single-acting type, developing 200 b-hp. at 185 r.p.m., and is direct-connected to a D.C. generator. The cylinders are 16 15/16 by 25¼ in.; the weight of the engine complete is 33,000 lb. The company announces that test-runs can be arranged by correspondence with the company or Arthur Fuller, Western sales manager, 24 Coleman Dock, Seattle, Washington.

The HESS FLUME CO., 2166-76 Fifteenth street, Denver, Colorado, announces the purchase of the Maginnis flume patents, covering both the Maginnis standard flume and the Maginnis smooth interior flume, together with the business, stock, and good-will of P. Maginnis of Kimball, Nebraska. The Hess company will continue the manufacture of both the Maginnis flume and the Hess flume at both its Denver and Canton, Ohio, factories.

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